BY ORDER OF THE
SECRETARY OF THE AIR FORCE

AIR FORCE MANUAL 32-1123(I)
ARMY TECHNICAL MANUAL, TM 5-803-7
NAVAL FACILITIES ENGINEERING COMMAND PUBLICATION P-971
1 MAY 1999

Civil Engineering

AIRFIELD AND HELIPORT PLANNING AND DESIGN

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

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Supersedes AFI 32-1026 (5 Mar 97), AFJMAN 32-1013, Vol 1, (12 May 81) and AFMAN 32-1013, Vol 2 (1 Oct 97)

Pages: 302/Distribution: F

This manual provides standardized criteria for all Department of Defense (DoD) airfields and heliports. It also implements Air Force Policy Directive (AFPD) 32-10, *Installations and Facilities*, by providing standards and criteria for developing, designing, and siting airfield and heliport facilities, and by establishing a waiver process for deviations when these standards and criteria cannot be met. See attachment 1 for a glossary of references and supporting information.

SUMMARY OF REVISIONS

This is the initial publication of AFJMAN 32-1013(I) and TM 5-803-7. It replaces Air Force AFI 32-1026, AFJMAN 32-1013, Vol 1 and AFMAN 32-1013, Vol 2; Army TM 5-803-4; and Navy NAVFAC P-971. It consolidates and updates guidance for application of DoD airfield and heliport criteria, incorporates Army planning criteria, and expands the information for airfield and heliport support facilities. It also deletes or updates references to former Air Force, Army, and Navy standards when replacement documents have been published. Chapters 3 and 5 significantly revise Class B fixed-wing airfield criteria for U.S. Army facilities. Chapter 4 expands rotary-wing landing and imaginary surface standards and adds criteria for Air Force helicopter Slide Areas. This manual updates wingtip clearances for parking aprons and describes Air Mobility Command's policy for applying these criteria. It reserves Chapter 7 for future criteria for Short Fields and Assault Landing Zones constructed for training purposes and adds Chapter 8 to provide criteria for aircraft hangar pavements.

Chapter 1—General Requirements 1-1
1.1 Purpose of This Manual 1-1
1.2 Scope 1-1
1.3 References 1-2
1.4 Application of Criteria 1-2
1.5 Service Requirements 1-2
1.6 Theater of Operations 1-2
1.7 Security Considerations for Design 1-3
1.8 Waivers to Criteria 1-3
1.9 Notice of Construction 1-3
1.10 Zoning 1-3
1.11 Construction Phasing Plan 1-4
1.12 Associated Design Manuals 1-4
1.13 Use of Terms 1-4

Chapter 2—Aviation Facilities Planning 2-1
2.1 Applicability 2-1
2.2 Justification 2-3
2.3 General Planning Considerations 2-3
2.4 Planning Studies 2-5
2.5 Siting Aviation Facilities (Army Only) 2-7
2.6 Airside and Landside Facilities 2-9
2.7 Landing and Takeoff Area 2-9
2.8 Aircraft Ground Movement and Parking Areas 2-10
2.9 Aircraft Maintenance Area (Other than Pavements) 2-12
2.10 Aviation Operations Support Area 2-13

Chapter 3—Runways (Fixed-Wing) and Imaginary Surfaces 3-1
3.1 Contents 3-1
3.2 Requirements 3-1
3.3 Runway Classification 3-1
3.4 Runway Systems 3-2
3.5 Runway Orientation/Wind Data 3-2
3.6 Additional Considerations for Runway Orientation 3-6
3.7 Runway Designation 3-8

3.8 Runway Dimensions 3-8
3.9 Shoulders 3-27
3.10 Runway Overruns 3-27
3.11 Runway Clear Zones 3-29
3.12 Accident Potential Zones (APZ) 3-29
3.13 Airspace Imaginary Surfaces 3-29
3.14 Airspace for Aviation Facilities with Two or More Runways 3-37
3.15 Obstruction to Air Navigation 3-37
3.16 Aircraft Arresting Systems 3-38

Chapter 4—Rotary-Wing Runways, Helipads, Landing Lanes, and Hoverpoints 4-1
4.1 Contents 4-1
4.2 Landing and Take-off Layout Requirements 4-1
4.3 Rotary-Wing Runway 4-1
4.4 Helipads 4-7
4.5 Same Direction Ingress/Egress 4-9
4.6 Hoverpoints 4-9
4.7 Rotary-Wing Landing Lanes 4-10
4.8 Helicopter Slide Areas or “Skid Pads” 4-16
4.9 Shoulders for Rotary-Wing Facilities 4-16
4.10 Overruns for Rotary-Wing Runways and Landing Lanes 4-16
4.11 Clear Zone and Accident Potential Zone (APZ) 4-16
4.12 Imaginary Surfaces for Rotary-Wing Runways, Helipads, Landing Lanes and Hoverpoints 4-21
4.13 Obstructions and Airfield Airspace Criteria 4-28

Chapter 5—Taxiways 5-1
5.1 Contents 5-1
5.2 Taxiway Requirements 5-1
5.3 Taxiway Systems 5-1
5.4 Taxiway Layout 5-1
5.5 Fixed-Wing Taxiway Dimensions 5-4
5.6 Rotary-Wing Taxiway Dimensions 5-7
5.7 Taxiways at Dual Use (Fixed- and Rotary-Wing) Airfields 5-7
5.8 Taxiway Intersection Criteria 5-7

5.9 High-Speed Taxiway Turnoff Criteria 5-10
5.10 Apron Access Taxiways 5-10
5.11 Shoulders 5-10
5.12 Towways 5-13
5.13 Hangar Access 5-13

Chapter 6—Aprons and Other Pavements 6-1
6.1 Contents 6-1
6.2 Apron Requirements 6-1
6.3 Types of Aprons and Other Pavements 6-1
6.4 Aircraft Characteristics 6-1
6.5 Parking Apron for Fixed-Wing Aircraft 6-1
6.6 Taxiing Characteristics on Aprons for Fixed-Wing Aircraft 6-9
6.7 Parking Apron for Rotary-Wing Aircraft 6-9
6.8 Warm-Up Pads 6-18
6.9 Power Check Pad 6-25
6.10 Arm/Disarm Pads 6-29
6.11 Compass Calibration Pad (CCP) 6-34
6.12 Hazardous Cargo Pads 6-37
6.13 Alert Pad 6-39
6.14 Aircraft Wash Racks 6-43
6.15 Hangar Access Aprons 6-52
6.16 Taxiing Characteristics on Aprons for Rotary-Wing Aircraft 6-54
6.17 Fixed-Wing and Rotary-Wing Grading Standards 6-54
6.18 Shoulders 6-55
6.19 Miscellaneous Apron Design Considerations 6-55
6.20 Jacking Considerations 6-55

Chapter 7—Shortfields and Training Assault Landing Zones - (Reserved for future use) 7-1

Chapter 8—Aircraft Hangar Pavements 8-1
8.1 General Requirements 8-1
8.2 Aircraft Modules Space 8-1
8.3 Hangar and Shelter Clearances 8-1
8.4 Hangar Floor Design 8-2

Figures

2.1. Aviation Facilities Planning Process 2-2
3.1. Runway and Primary Surface Transverse Sections 3-9
3.2. Clear Zone Transverse Section Detail 3-10
3.3. Runway and Overrun Longitudinal Profile....3-11
3.4. Army Clear Zone and Accident Potential Zone Guidelines 3-12
3.5. Air Force Clear Zone and Accident Potential Zone Guidelines 3-13
3.6. Navy and Marine Corps Clear Zone and Accident Potential Zone Guidelines 3-14
3.7. Class A VFR Runway Primary Surface End Details 3-15
3.8. Class A VFR Runway Isometric Airspace Imaginary Surfaces....3-16
3.9. Class A VFR Runway Plan and Profile Airspace Imaginary Surfaces 3-17
3.10 Class A IFR Runway Primary Surface End Details....3-18
3.11. Class A IFR Runway Airspace Imaginary Surfaces 3-19
3.12. Class A IFR Runway Plan and Profile Airspace Imaginary Surfaces....3-20
3.13. Class B Army and Air Force Runway Primary Surface End Details....3-21
3.14. Class B Army and Air Force Runway Airspace Imaginary Surfaces 3-22
3.15 Class B Army and Air Force Runway Airspace Plan and Profile Runway Imaginary Surfaces 3-23
3.16. Class B Navy Runway Primary Surface End Details....3-24
3.17. Class B Navy Runway Airspace Imaginary Surfaces 3-25
3.18 Class B Navy Runway Airspace Plan and Profile Runway Imaginary Surfaces 3-26
3.19 VFR and IFR Crosswind Runways Isometric Airspace Imaginary Surfaces....3-27
4.1 Air Force, Navy, and Marine Corps Helicopter VFR Runway....4-4
4.2 Army Helicopter Runway and Air Force, Navy, and Marine Corps Helicopter IFR Runway 4-5
4.3 Airspace Imaginary Surfaces, Army Helicopter Runway and Helipad, and Air Force, Navy, and Marine Corps IFR Helicopter Runway and Helipad 4-6
4.4 Standard VFR Helipad for Air Force....4-10
4.5 Standard VFR Helipad for Navy and Marine Corps and Limited Use VFR Helipad for Air Force....4-11
4.6 Army Helipad and Air Force, Navy, and Marine Corps IFR Helipad 4-12
4.7 Air Force Helipad with Same Direction Ingress/Egress 4-13

4.8 Army Helipad with Same Direction Ingress/Egress and Air Force IFR Helipad with Same Direction Ingess/Egress 4-14
4.9 Helicopter Landing Zone 4-15
4.10 Helicopter Hoverpoint 4-19
5.1 Common Taxiway Designations....................5-2
5.2 Spacing Requirements - Normal Taxiway Turnoffs....................5-3
5.3 Taxiway and Primary Surface Transverse Sections....................5-8
5.4 Intersection Geometry for Army and Air Force Facilities, and Navy and Marine Corps Facilities Serving Aircraft with Wingspan Less Than 33.5 meters (110 feet) 5-11
5.5 Intersection Geometry for Navy and Marine Corps Facilities Serving Aircraft with Wingspan Greater Than 33.5 meters (110 feet) 5-12
5.6 Toway Criteria 5-15
6.1 Apron Nomenclatures and Criteria 6-2
6.2 Army and Air Force Parking Plan....................6-4
6.3 Truck Refueling Safety Zone Example....................6-5
6.4 Apron With Diagonal Parking 6-10
6.5 Type 1 Parking for All Aircraft Except CH-47....................6-12
6.6 Type 1 Parking for CH-47 6-13
6.7 Type 2 Parking for Skid Aircraft 6-14
6.8 Type 2 Parking for Wheeled Aircraft 6-15
6.9 Warm-Up Pad at End of Parallel Taxiway 6-19
6.10 Warm-Up Pad Next to Parallel Taxiway 6-19
6.11 Warm-Up Pad Located in Clear Zone 6-20
6.12 Warm-Up Pad Located in Approach-Departure Clearance Surface 6-21
6.13 Warm-Up Pad/Localizer Critical Area 6-22
6.14 Air Force Warm-Up Pad/Glide Slope Critical Area....................6-23
6.15 Warm-Up Pad/CAT II ILS Critical Area....................6-24
6.16 Warm-Up Pad Taxiing and Wingtip Clearance Requirements....................6-25
6.17 Geometry for Rectangular Power Check Pad 6-26
6.18 Geometry for Square Power Check Pad 6-27
6.19 Geometry for Circular Power Check Pad 6-28
6.20 Arm-Disarm Pad for F-4 Fighter 6-31
6.21 Arm-Disarm Pad for F-15 Fighter 6-32

6.22 Arm-Disarm Pad for F-16 Fighter 6-33
6.23 Arm-Disarm Pad for F-111 Fighter 6-34
6.24 Army and Air Force Compass Calibration Pad 6-36
6.25 Hazardous Cargo Pad Other Than APOE/Ds 6-38
6.26 Typical Hazardous Cargo Pad for APOE/Ds....................6-38
6.27 Typical Alert Apron for Bombers and Tanker Aircraft 6-40
6.28 Typical Alert Pad for Fighter Aircraft 6-40
6.29 Alert Apron Taxi-In/Taxi-Out Parking....................6-42
6.30 Alert Apron Back-In Parking....................6-43
6.31 Wash Rack for Mixed Mission Facility....................6-45
6.32 Heavy Bomber Wash Rack (B-52 or B-1) 6-46
6.33 Cargo Aircraft Wash Rack....................6-47
6.34 Fighter Aircraft Wash Rack and Navy Type A Wash Rack 6-48
6.35 Navy Type B Wash Rack....................6-49
6.36 Helicopter Wash Rack 6-50
6.37 Utilities and In-Pavement Structures 6-51

Tables

1.1. Associated Design Manuals....................1-4
3.1. Runway Classification by Aircraft Type....................3-1
3.2. Runways....................3-3
3.3. Army Class A Runway Lengths....................3-28
3.4. Overruns....................3-28
3.5. Clear Zones 3-30
3.6. Accident Potential Zones (APZ) 3-32
3.7. Airspace Imaginary Surfaces (Approach-Departure Clearance Surface)....................3-33
3.8. Imaginary Surfaces Minimum Clearances Over Highway, Railroad, Waterway, and Trees 3-38
4.1. Rotary-Wing Runways....................4-1
4.2. Rotary-Wing Helipads and Hoverpoints....................4-7
4.3. Rotary-Wing Landing Lanes....................4-17
4.4. Shoulders for Rotary-Wing Facilities 4-18
4.5. Overruns for Rotary-Wing Runways and Landing Lanes....................4-20

4.6. Rotary-Wing Runway and Landing Lane Clear Zone and Accident Potential Zone (APZ) 4-21
4.7. Rotary-Wing Imaginary Surface for VFR Approaches 4-22
4.8. Rotary-Wing Imaginary Surfaces for IFR Approaches 4-25
5.1. Fixed-Wing Taxiways 5-4
5.2. Rotary-Wing Taxiways 5-9
5.3. Rotary-Wing Taxiway Shoulders 5-9
5.4. Towways 5-13
6.1. Fixed-Wing Aprons 6-6
6.2. Rotary-Wing Aprons for Army Airfields 6-16
6.3. Minimum Separation Distance on Bomber Alert Aprons from the Centerline of a Through Taxilane to a Parked Aircraft 6-41
6.4. Wash Rack Clearances From Aircraft to Curb 6-44
6.5. Hangar Access Apron 6-53
8.1. Aircraft Space Module for Army Aviation Facilities 8-1
8.2. Aircraft Clearances Inside Hangars 8-2

Attachments

Attachment 1 ---- GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION A1-1
Attachment 2 ---- WAIVER PROCESSING PROCEDURES A2-1
Attachment 3 ---- ARMY LAND USE AND FACILITY SPACE – ALLOWANCES A3-1
Attachment 4 ---- DEPARTMENT OF DEFENSE LAND USE COMPATIBILITY GUIDELINES FOR CLEAR ZONE AND ACCIDENT POTENTIAL ZONES A4-1
Attachment 5 ---- WIND COVERAGE STUDIES A5-1
Attachment 6 ---- STANDARDS FOR DETERMINING OBSTRUCTIONS – FAR PART 77, PARAGRAPHS 77.13, 77.15, 77.17 and 77.23 .... A6-1
Attachment 7 ---- AIRCRAFT CHARACTERISTICS FOR AIRFIELD-HELIPORT DESIGN AND EVALUATION A7-1
Attachment 8 ---- JET BLAST EFFECTS A8-1
Attachment 9 ---- JET BLAST DEFLECTOR A9-1
Attachment 10--- EXPLOSIVES ON OR NEAR AIRFIELDS A10-1
Attachment 11--- COMPASS CALIBRATION PAD (CCP) MAGNETIC SURVEY A11-1
Attachment 12--- TIEDOWNS, MOORING, AND GROUNDING POINTS A12-1
Attachment 13--- FLIGHTLINE VEHICLE PARKING - NAVY AND MARINE CORPS A13-1
Attachment 14--- DEVIATIONS FROM CRITERIA FOR AIR FORCE AIRFIELD SUPPORT FACILITIES A14-1
Attachment 15--- CONSTRUCTION PHASING PLAN A15-1
Attachment 16--- MISCELLANEOUS FIGURES A16-1
Attachment 17--- NAVIGATIONAL AIDS (NAVAIDS) DESIGN AND SUPPORT A17-1
Attachment 18--- AIR TRAFFIC CONTROL TOWER (ATCT) SITING CRITERIA A18-1

Chapter 1

GENERAL REQUIREMENTS

1.1. Purpose of This Manual. This manual provides standardized airfield, heliport and airspace criteria for the geometric layout, design, and construction of runways, helipads, taxiways, aprons, and related permanent facilities to meet sustained operations.

1.2. Scope. This manual prescribes dimensional and geometric layout criteria for safe standards for airfields, landing zones, heliports and helipads, and related permanent facilities, as well as the navigational airspace surrounding these facilities. Criteria in this manual pertain to all Department of Defense (DoD) military facilities in the United States, its territories, trusts, and possessions, and unless otherwise noted, to DoD facilities overseas on which the United States has vested base rights. For DoD facilities overseas, there may be more applicable governing authority from agencies such as host nation, International Civil Aviation Organization (ICAO), or NATO. Procedures for pavement structural design and pavement marking are beyond the scope of this manual. Tenant organizations on civil airports will use these criteria to the extent practicable; otherwise, Federal Aviation Administration (FAA) criteria will apply.

1.2.1. Terminal Instrument Procedures (TERPS). Modifications to existing facilities and construction of new facilities must be closely coordinated with the Major Command (MAJCOM - Air Force), U.S. Army Aeronautical Services Agency (USAASA) and USAASDE, and Naval Flight Information Group (NAVFIG), to ensure instrument flight procedures' compliance with TERPS. The criteria in this manual do not address instrument flight procedures. TERPS evaluations and processes are described in AFJMAN 11-226/TM 95-226/OPNAVINST 3722.16C, *United States Standard for Terminal Instrument Procedures (TERPS)*. TERPS provides additional criteria to be considered when designing or modifying airfields and facilities on airfields that are used under Instrument Flight Rules (IFR).

1.2.2. Objects Affecting Navigable Airspace. Modifications to existing facilities and construction of new facilities must consider navigable airspace. The criteria for determining obstructions to navigable airspace have been identified in this manual. The designer must consult this manual during the design process to identify obstructions to airspace. For facilities outside the U.S. and its trust territories, host nation criteria apply. If the criteria in this manual are more stringent, this manual should be used to the maximum extent practical.

1.2.3. Navigational Aids (NAVAIDS) and Lighting. NAVAIDS and airfield lighting are integral parts of an airfield and must be considered in the planning and design of airfields and heliports. NAVAID location, airfield lighting, and the grading requirements of a NAVAID must be considered when locating and designing runways, taxiways, aprons and other airfield facilities. Table A17.1 in Attachment 17 includes a list of design documents governing NAVAIDS and lighting and the agency where siting and design information can be obtained.

1.2.4. Vertical-Short Takeoff and Landing (V-STOL) Aircraft (V-22). At shore establishments, the V-22 will be considered a fixed-wing aircraft, and the runway planned according to critical field length. If operational requirements allow for reduced loads and a vertical takeoff pad is desired, contact the appropriate agency aviation office who can provide airfield safety waivers. This manual does not cover design criteria for V-STOL aircraft. Information on the V-22 (Osprey) aircraft may be obtained by contacting:

LANTDIV Code 15		NAVAIRSYSCOM (AIR-8.OY)
1510 Gilbert Street	OR	1421 Jefferson Davis Highway
Norfolk, VA 23511-2699		Arlington VA 22243-5120

1.3. References. Attachment 1 contains a list of documents referenced in this manual.

1.4. Application of Criteria:

1.4.1. Existing Facilities. The criteria in this manual are not intended to apply to existing facilities located or constructed under previous standards. These facilities can continue to be used without impairing operational efficiency and safety. Existing airfield facilities need not be modified nor upgraded to conform to the criteria in this manual. If there is a change in mission which results in a reclassification of the facility, an upgrade to current standards is required. Upgraded facilities must be maintained at a level that will sustain compliance with current standards.

1.4.2. Modification of Existing Facilities. When existing airfield facilities are modified, construction must conform to the criteria established in this manual unless waived in accordance with paragraph 1.8.. Modified facilities must be maintained at a level that will sustain compliance with current standards.

1.4.3. New Construction. The criteria established in the manual apply to all new facilities. All new construction will comply with criteria established within this manual unless the appropriate waivers are obtained as outlined in Attachment 2.. New facilities must be maintained at a level that will sustain compliance with current standards.

1.4.4. Metric Application. Geometric design criteria established in this manual are expressed in SI units (metric). These metric values are based upon aircraft specific requirements rather than direct conversion and rounding. This results in apparent inconsistencies between metric and inch-pound (English) dimensions. For example, 150-foot-wide runways are shown as 46 meters, 150-foot-wide aircraft wash racks are shown as 45 meters. Runways need the extra meter in width for aircraft operational purposes; wash racks do not. SI dimensions apply to new airfield facilities, and where practical, to modification of existing airfield facilities, unless waived in accordance with paragraph 1.8. Inch-pound measurements are included in the tables and figures in this manual only to permit reference to the previous standards. To avoid changes to existing airfield obstruction maps and compromises to flight safety, airfield and heliport imaginary surfaces and safe wingtip clearance dimensions are shown as a direct conversion from inch-pound to SI units.

1.4.5. AFRC and ANG Installations. AFRC and ANG installations on municipal airports or FAA-controlled airfields must apply FAA criteria to facilities such as runways and taxiways that are jointly used by civilian and military aircraft. Facilities that are for military use only, such as aircraft parking aprons, must apply Air Force/DoD criteria.

1.5. Service Requirements. When criteria differ among the various Services, the criteria for the specific Service are noted.

1.6. Theater-of-Operations. Standards for theater-of-operations facilities are contained in: Army FM 5-430-00-2/Air Force Joint Pamphlet (AFJPAM) 32-8013, Volume 2, *Planning and Design of Roads, Airfields, and Heliports in the Theater of Operations*.

1.7. Security Considerations for Design. Regulatory requirements for security of assets can have a significant impact on planning and design of airfields and heliports. The arms, ammunition, explosives and electronic devices associated with aircraft, as well as the aircraft themselves, require varying types and levels of protection. Operational security of the airfield is also a consideration.

1.7.1. Integration of Security Measures. Protective features such as barriers, fences, lighting, access control, intrusion detection and assessment must be integrated into the airfield planning and design process to minimize problems with aircraft operations and safety requirements. This is discussed further in Chapter 2. The protective measures should be included in the design based on risk and threat analysis or should comply with security-related requirements.

1.7.2. Security-Related Requirements. Detailed discussion of security-related requirements is beyond the scope of this manual. Designer should refer to the following applicable security regulations for planning and design guidance:

1.7.2.1. AFI 31-101, *The Physical Security Program*

1.7.2.2. OPNAVINST 5513.14B, *Physical Security and Loss Prevention*

1.7.2.3. MIL-HDBK-1013/1, *Design Guidelines for Physical Security of Facilities*

1.7.2.4. MIL-HDBK-1013/10, *Design Guidelines for Security Fencing, Gates, Barriers and Guard Facilities*

1.7.2.5. (U)AR 50-51, *Nuclear Weapons Security, (Confidential*)

1.7.2.6. AR 190-11, *Physical Security of Arms, Ammunition and Explosives*

1.7.2.7. AR 190-51, *Security of Army Property at Unit and Installation Level*

1.7.2.8. DA PAM 190-51, *Risk Analysis for Army Property*

1.8. Waivers to Criteria. Each DoD Service component is responsible for setting administrative procedures necessary to process and grant formal waivers. Waivers to the criteria contained in this manual will be processed in accordance with Attachment 2. If a waiver affects instrument approach and departure procedures as defined in TERPS (AFJMAN 11-226/TM 95-226/OPNAVINST 3722.16C), the DoD Service component processing the waiver must also coordinate its action with the applicable TERPS approving authority.

1.9. Notice of Construction. The FAA must be notified of all construction that affect air navigation at DoD airfields in the United States and its territories. FAA Form 7460-1, **Notice of Proposed Construction or Alteration (**http://www.faa.gov/arp/ace/faaforms.htm), must be submitted to the Federal Aviation Administration at least 30 days prior to the start of construction, in accordance with Federal Aviation Regulations, Part 77, *Objects Affecting Navigable Airspace*, subpart B. Airspace surface penetrations will be noted. Applications may be obtained and are filed with the regional FAA office. For Army, Army National Guard and Army Reserves, process the form in accordance with Chapter 8 of AR 95-2, *Air Traffic Control, Air Space, Airfield Flight Facilities and Navigational Aids*. For DoD facilities overseas, similar requirements by the host country, NATO, or ICAO, may be applicable.

1.10. Zoning. Existing and new facilities should encourage local municipalities to adopt compatible Land Use Zoning to protect air space on and off airfield facilities.

1.11. Construction Phasing Plan. A construction phasing plan, as discussed in Attachment 15, should be included in the contract documents.

1.12. Associated Design Manuals. The planning and design of airfields and heliports is intricate and may require additional criteria, such as pavement design and pavement marking, not addressed in this manual. Additional manuals which the designer/planner may need to consult are listed in Table 1.1.

1.13. Use of Terms. The following terms, when used in this manual, indicate the specific requirements:

1.13.1. *Will* or *Must* -- Indicates a mandatory and/or required action.

1.13.2. *Should* -- Indicates a recommended, advisory, and/or desirable action.

1.13.3. *May* or *Can* -- Indicates a permissible action.

Table 1.1. Associated Design Manuals.

Pavement Design, General	
Air Force	AFJMAN 32-1014, *Pavement Design for Airfields*
Army	TM-5-825-1, *General Provisions for Airfield/Heliport Pavement Design*
	TM-5-825-3-1, *Rigid Pavement Design for Airfields, Elastic Layered Method*
	TM-5-825-2-1, *Flexible Pavement Design for Airfields (Elastic Layered Method)*
Navy/Marines	MIL-HDBK 1021/2, *General Concepts for Airfield Pavement Design*
FAA	AC 150/5320-6, *Airport Pavement Design and Evaluation*
Hangar Pavement Design	
Navy/Marines	MIL-HDBK 1028/1A, *Aircraft Maintenance Facilities*
Rigid Pavement Design	
Air Force	AFJMAN 32-1014, *Pavement Design for Airfields*
Army	TM 5-825-3, *Rigid Pavements for Airfields*
Navy/Marines	MIL-HDBK 1021/4, *Rigid Pavement Design for Airfields*
FAA	AC 150/5320-6, *Airport Pavement Design and Evaluation*
Flexible Pavement Design	
Air Force	AFJMAN 32-1014, *Pavement Design for Airfields*
Army	TM 5-825-2, *Flexible Pavement Design for Airfields*
Navy/Marines	DM 21.3, *Flexible Pavement Design for Airfields*
FAA	AC 150/5320-6, *Airport Pavement Design and Evaluation*
Surface Drainage	
Air Force	AFM 88-5, CH1 (AFI 32-1016), *Surface Drainage Facilities for Airfields and Heliports*
Army	TM 5-820-1, *Surface Drainage Facilities for Airfields/Heliports*
Navy/Marines	MIL-HDBK 1005/3, *Drainage Systems*
FAA	AC 150/5320-5, *Airport Drainage*
Airfield Lighting	
Air Force	AFMAN 32-1076, *Visual Air Navigation Facilities*
Army	TM 5-811-5, *Army Aviation Lighting*
Navy/Marines	MIL-HDBK 1023/1, *Airfield Lighting*
	NAVAIR 51-50AAA-2, *General Requirements for Shore Based Airfield Marking and Lighting*
	MIL-HDBK 1024/1, *Aviation Operational and Support Facilities*
FAA	AC 150/5300-13, *Airport Design*

Table 1.1. Associated Design Manuals (Continued).

Explosives	
Air Force	AFMAN 91-201, *Explosives Safety Standards*
Army	AR 385-64, *Ammunition and Explosives Safety Standards*
Navy/Marines	NAVSEA OP-5, *Ammunition and Explosives Ashore, Safety Regulations for Handling, Storing, Production, Renovation, and Shipping*
Pavement Marking	
Air Force	AFI 32-1042, *Standards For Marking Airfields*
	ETL 94-01, *Standard Airfield Pavement Marking Schemes* (AFJM 32-1015)
Army	TM 5-823-4, *Marking of Army Airfield-Heliport Facilities*
Navy/Marines	NAVAIR 51-50AAA-2
FAA	AC 150/5340-1, *Marking of Paved Areas on Airports*
Subsurface Drainage	
Air Force	AFM 88-5, CH2 (AFJMAN 32-1016), *Drainage and Erosion Control - Subsurface Drainage, Facilities and Airfield Pavements*
Army	TM 5-820-2, *Drainage and Erosion Control, Subsurface Drainage Facilities for Airfield Pavements*
Navy/Marines	DM 21.06, *Airfield Subsurface Drainage and Pavement Design*
FAA	AC 150/5320-5, *Airport Drainage*
Drainage and Erosion Control Structures	
Air Force	AFM 88-5, CH3 (AFJMAN 32-1016), *Drainage and Erosion Control Structure for Airfields and Heliports*
Army	TM 5-820-3, *Drainage and Erosion Control Structures for Airfields and Heliports*
Navy/Marines	MIL HDBK 1005/3, *Drainage Systems*
FAA	AC 150/5320-5, *Airport Drainage*
Theater of Operations	
Air Force	AFJPAM 32-8013, Vol 2 (32-1027V1), *Planning and Design of Roads, Airfields, and Heliports in the Theater of Operations--Road Design*
Army	FM 5-430-00-2
Area Lighting	
Army	TM 5-811-5, *Army Aviation Lighting*
Navy/Marines	MIL-HDBK 1023/1, *Airfield Lighting*
	NAVAIR 51-50AAA-2, *General Requirements for Shore Based Airfield Marking and Lighting*
FAA	IES-RP-14-1987, *IES Recommended Practice for Airport Service Area Lighting*

(   ) - Represents Future Document

Chapter 2

AVIATION FACILITIES PLANNING

2.1. Applicability. Much of the criteria in this chapter apply to Aviation Facilities Planning for the Army only and are intended for use together with the design criteria presented elsewhere in this manual. Use of these criteria produces the right facilities, in the right place, at the right time. Navy aviation planning is covered in NAVFAC P-80, *Facility Planning Factor Criteria for Navy and Marine Corps Shore Installations*, and NAVFAC P 80.3, Appendix E, *Airfield Safety Clearances*. Aviation facilities planning for the Air Force is discussed in Air Force Instruction (AFI) 32-1024, *Standard Facility Requirements*, and Air Force Handbook (AFH) 32-1084, *Standard Facility Requirements Handbook*. In some cases, Air Force and Navy agencies and documents have been noted.

2.1.1. Manual Usage. Integration of aviation facilities planning with other Department of Defense (DoD) planning processes entails broad considerations. For example, the National Environmental Policy Act of 1969 (NEPA) has significantly affected aviation facilities planning by requiring that environmental impacts be considered early and throughout the planning process. In using this manual, planners should recognize that planning an aviation facility not only requires planning for runways, taxiways, aprons, and buildings, but must also consider environmental factors, land use considerations, airspace constraints, and surrounding infrastructure.

2.1.2. Terms. The following terms, for the purpose of this manual, define cumulative areas of consideration when planning aviation facilities. These terms are defined in attachment 1.

2.1.2.1. Aviation facility

2.1.2.2. Airside facilities

2.1.2.3. Landside facilities

2.1.2.4. Aviation movement or action

2.1.3. Planning Process. Aviation facilities planning involves collecting data, forecasting demand, determining facility requirements, analyzing alternatives, and preparing plans and schedules for facility development. The aviation facilities planning process must consider the mission and use of the aviation facility and its effect on the general public. The planning process cannot be completed without knowing the facility's primary mission and assigned organization and types of aircraft. Figure 2.1 provides general steps in the aviation facilities planning process.

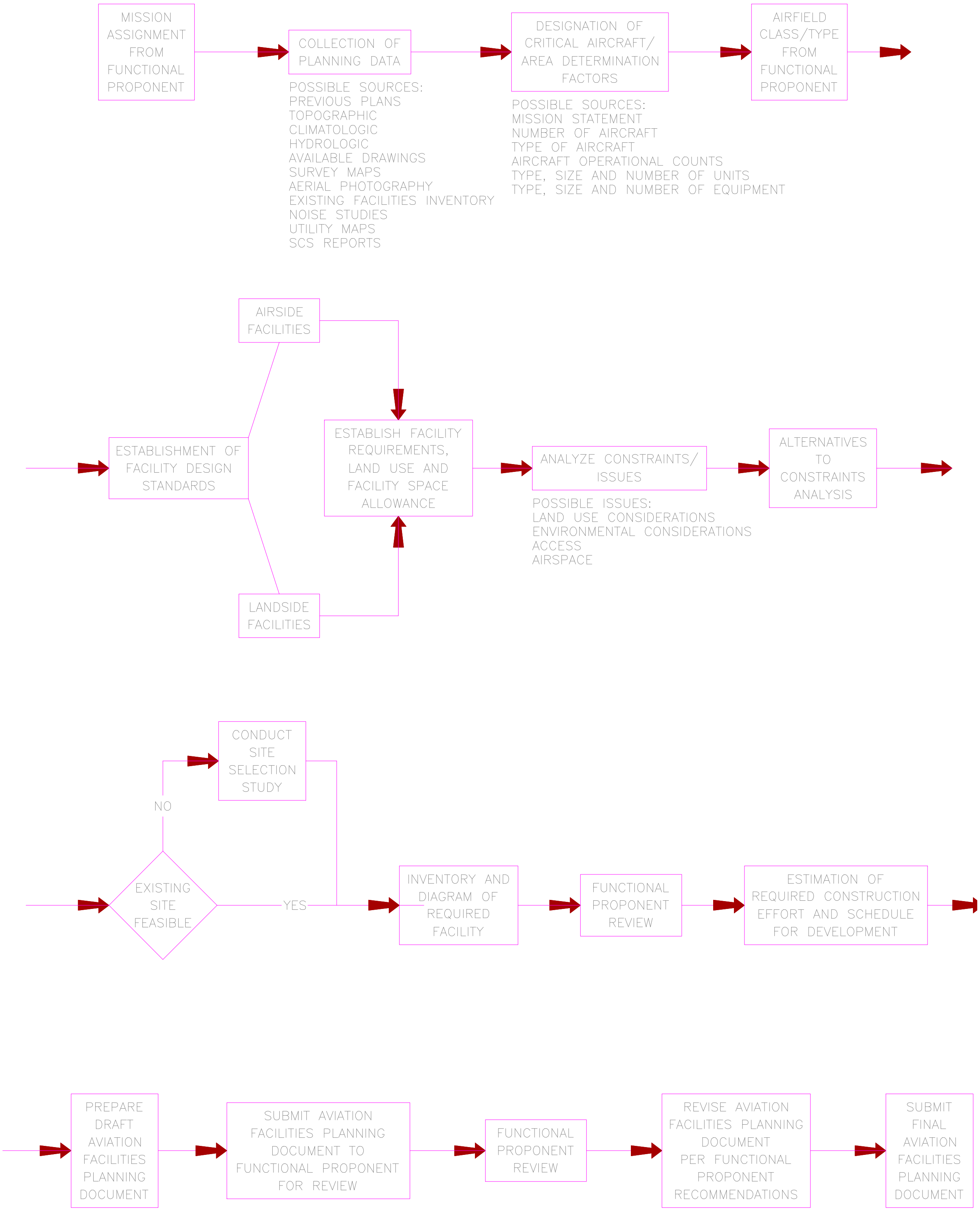
2.1.4. Planning Elements. The elements of an aviation facility's planning process will vary in complexity and degree of application, depending on the size, function, and problems of the facility. The technical steps described in this manual should be undertaken only to the extent necessary to produce a well-planned aviation facility.

2.1.5. Guidance. This chapter is structured and organized to provide guidance to planners intending to plan, design, or modify an aviation facility to comply with standardized criteria.

2.1.6. Additional Planning Factors. As discussed in Chapter 1, there are additional planning factors such as pavement design, airfield marking, and Terminal Instrument Procedures (TERPS) that must be considered when planning aviation facilities.

2.1.7. Space Allowances. Space allowances, presented in attachment 3, should be used when planning Army aviation facilities. Space allowances are presented in NAVFAC P-80 for Navy facilities and AFH 32-1084, *Facility Requirements Handbook*, for Air Force facilities.

Figure 2.1. Aviation Facilities Planning Process.



2.2. Justification:

2.2.1. Aviation Facilities Planning. Aviation facilities must be planned, programmed, and constructed in accordance with the Airfield Master Plan process. An Airfield Master Plan is developed and approved through an established planning process as discussed in paragraph 2.4. During the Master Plan process, alternatives must be assessed to determine the best, or a combination of, alternative(s) which overcome deficiencies at an aviation facility. Consideration must be given to construction alternatives (to construct new, modify, or upgrade a substandard facility) combined with operational alternatives (rescheduling and sharing facilities, changing training or mission) to determine the best plan for meeting facility requirements. As a minimum, each alternative considered must identify the changes to the mission, personnel, weapons systems and equipment, and any other impact to the facility. Construction of a new aviation facility is authorized when: (1) operational alternatives considered have been assessed and it has been concluded that the alternatives are not viable or executable options; or (2) existing facilities have been assessed as inadequate to meet the mission and new airside and/or landside facilities are not feasible.

2.2.2. Number of Aircraft. The construction and operating cost of an airfield for a few miscellaneous aircraft usually cannot be justified from the standpoint of military necessity or economy when those aircraft can be accommodated at an existing airfield within 32 kilometers (20 miles). Planning efforts must consider the number of aircraft assigned to the mission and review alternatives for using existing airfields which have capacity to satisfy mission requirements.

2.2.3. Joint Use Facilities. Use of existing facilities on a civil airfield, or the airfield of another service, should be considered when feasible.

2.3. General Planning Considerations:

2.3.1. Goals and Objectives. The goals and objectives of planning an aviation facility, as set forth in this manual, are to ensure sustained, safe, economical and efficient aircraft operations and aviation support activities. Planners must consider both the present and potential uses of the aviation facility during peacetime, mobilization, and emergency operations.

2.3.2. Functional Proponent. The functional proponent responsible to justify the need, scope (size), and utilization of an aviation facility is discussed below. Engineers/planners should assist operations personnel with the planning and programming, definition and scope, site selection, and design of the facility.

2.3.2.1. Army. The functional proponent for developing the scope and requirements for Army aviation facilities is usually assigned to the Aviation Division, Directorate of Plans, Training and Mobilization (DPTM) of the installation staff or the Operations Section (G/S-3) of the senior aviation organization. At locations where there is no DPTM or G/S-3 office, facility planners must coordinate with the commander of the aviation units to be supported. The DPTM, as the primary functional proponent, is responsible for determining mission support requirements for aviation facilities, operations, safety, and air traffic.

2.3.2.2. Air Force. The functional proponent for the Air Force is the Major Command (MAJCOM).

2.3.2.3. Navy. The functional proponent for the Navy is the Activity Commanding Officer.

2.3.3. Requirements. Each functional proponent is responsible for providing the appropriate operational information to be used in the planning of an aviation facility. In addition, planning should be coordinated with all users (operations, air traffic control, safety) of the aviation facility, including the FAA, to determine immediate and long range uses of the aviation facility.

2.3.3.1. Operational Information. Functional proponents will provide, at a minimum, existing and projected operational information needed for planning aviation facilities:

2.3.3.1.1. Mission statements.

2.3.3.1.2. Aircraft operational counts, traffic levels, and traffic density.

2.3.3.1.3. Type, size, and number of units/organizations and personnel.

2.3.3.1.4. Type, size, and number of equipment (aircraft, weapons systems, vehicles, etc.).

2.3.3.1.5. Once the above items are established, land requirements to support the aircraft mission can be established.

2.3.3.2. Engineering Information. Engineering information provided will include, as a minimum: graphical maps and plans, facility condition assessments, and tabulation of existing facilities.

2.3.4. Safety. The planning and design of an aviation facility will emphasize safety for aircraft operations. This includes unobstructed airspace and safe and efficient ground movements. Protect air space by promoting conscientious land use planning, such as compatible zoning and land easement acquisition.

2.3.5. Design Aircraft. Aviation facilities typically are designed for a specific aircraft known as the "critical" or "design" aircraft, which is the most operationally and/or physically demanding aircraft to make substantial use of the facility. The critical or design aircraft is used to establish the dimensional requirements for safety parameters such as approach protection zones, lateral clearance for runways, taxiways and parking positions, and obstacle clearance. In many cases, the "geometric" design aircraft may not be the same aircraft as the "pavement" design aircraft.

2.3.6. Airspace and Land Area. Aviation facilities need substantial air space and land area for safe and efficient operations and to accommodate future growth or changes in mission support.

2.3.6.1. Ownership of Clear Zones and Accident Potential Zones. When planning a new aviation facility or expanding an existing one, clear zones should be either owned or protected under a long term lease, and Accident Potential Zones (APZ) should be zoned in accordance with DoD Instruction 4165.57, *Air Installation Compatible Use Zone (AICUZ).* Ownership of the APZ is desirable but not required.

2.3.6.2. Land Use Within the Clear Zone and Accident Potential Zones. Requirements for land use below approach-departure surfaces are provided in DoD Instruction 4165.57 and are summarized in Attachment 4.

2.3.6.3. Explosives. Where explosives or hazardous materials are handled at or near aircraft, safety and separation clearances are required. The clearances are based on quantity-distance criteria as discussed in Attachment 10.

2.3.6.4. Landside Safety Clearances. Horizontal and vertical operational safety clearances must be applied to landside facilities and will dictate the general arrangement and sizing of facilities and their relationship to airside facilities. Landside facilities will vary in accordance with the role of the mission. There are, however, general considerations which apply in most cases, such as:

2.3.6.4.1. Adherence to standards in support of safety in aircraft operations.

2.3.6.4.2. Non-interference with line of sight or other operational restrictions.

2.3.6.4.3. Use of existing facilities.

2.3.6.4.4. Flexibility in being able to accommodate changes in aircraft types or missions.

2.3.6.4.5. Efficiency in ground access.

2.3.6.4.6. Priority accorded aeronautical activities where available land is limited.

2.3.6.5. Helipads. Helipads are authorized at locations where aircraft are not permanently assigned but have a need for access based upon supporting a continuing and recurrent aviation mission. For example, hospitals, depot facilities, and headquarters buildings are authorized one or more helipads. These facilities must be included in the approved Airfield Master Plan.

2.3.6.6. Facilities Used by Multiple Services. At airfields used by multiple services, the planning and design of facilities will be coordinated between the appropriate services. The lead for coordination is the appropriate facilities/engineering echelon of the service which owns the facilities.

2.4. Planning Studies:

2.4.1. Master Plan. Knowledge of existing facilities, mission, and aircraft, combined with a realistic assumption of future requirements, is essential to the development of Master Plans. Principles and guidelines for development of Master Plans at an aviation facility are contained in the following publications:

2.4.1.1. Army: AR 210-20, *Master Planning for Army Installation*.

2.4.1.2. Air Force: AFI 32-7062, *Air Force Comprehensive Planning*.

2.4.1.3. Navy/Marines: E-I, *Installation Planning, Design and Management Guide* (Draft).

2.4.2. Land Use Studies. Long-range land use planning is a primary strategy for protecting a facility from problems which arise from aviation-generated noise and incompatible land uses. Aircraft noise can adversely affect the quality of the human environment. Federal agencies are required to work with local, regional, state, and other Federal agencies to foster compatible land uses, both on and off the boundaries of the aviation facility. The Air Installation Compatible Use Zone (AICUZ) and Installation Compatible Use Zone (ICUZ) programs promote land use compatibility through active land use planning.

2.4.3. Environmental Studies. Development of an aviation facility including expansion of an existing aviation facility requires compliance with a variety of environmental policies and regulations. NEPA requires all Federal agencies to consider the potential environmental impacts of certain proposed projects and activities, as directed by DoD Directives 6050.1, *Environmental Effects in the United States of DoD Actions*, and 6050.7, *Environmental Effects Abroad of Major Department of Defense Actions*. Implementation of these regulations is defined for each service in the following documents: Army: AR 200-2, *Environmental Effects of Army Actions*; Air Force: AFI 32-7061, *Environmental Impact Analysis Process*; and Navy and Marine Corps: OPNAVINST 5090.1B (MCO 5090.2), *Environmental and Natural Resources Program Manual*. Four broad categories of environmental review for a proposed action exist. The decision to conduct one study or another depends on the type of project and the potential consequences the project has to various environmental categories. Criteria for determining which type of study should be undertaken are defined in the environmental directives for each branch of service. Environmental studies should be prepared and reviewed locally. When additional assistance or guidance appears necessary, this support may be obtained through various agencies such as USAATCA, COE TSMCX (U.S. Army Corps of Engineers Transportation Systems Center) and the U.S. Army Corps of Engineers District Offices, Naval Facilities Engineering Command Headquarters and Engineering Field Divisions, and the Air Force Center for Environmental Excellence (HQ AFCEE).

2.4.3.1. Environmental Assessment (EA). The EA serves to analyze and document the extent of environmental consequences of a proposed construction project. It evaluates issues such as existing and future noise, land use, water quality, air quality, cultural resources, fish and wildlife. The conclusion of the assessment will result in either: (1) a Finding of No Significant Impact (FONSI), or if the consequences are significant, (2) the decision to conduct an Environmental Impact Statement (EIS). This decision is typically made by the authority approving the study.

2.4.3.2. Environmental Impact Statement (EIS). An EIS is the document which identifies the type and extent of environmental consequences created if the proposed project is undertaken. The EIS' primary purpose is to ensure that NEPA policies and goals are incorporated into the actions of the Federal government. The EIS defines the impact, and details what measures will be taken to minimize, offset, mitigate, or avoid any adverse effects on the existing environmental condition. Upon completion of an EIS, the decision maker will file a Record Of Decision (ROD), which finalizes the environmental investigation and establishes consent to either abandon or complete the project within the scope of measures outlined in the EIS.

2.4.3.3. Categorical Exclusion (CX). A CX is used for projects that do not require an EA or EIS because it has been determined that the projects do not have an individual or cumulative impact on the environment, and present no environmentally controversial change to existing environmental conditions. A list of actions which are categorically excluded is contained in the regulatory directives for each service.

2.4.3.4. Exemption By Law and Emergencies. Situations where laws applicable to the DoD prohibit, exempt, or make full compliance with NEPA impossible, or where immediate actions to promote national defense and security do not allow for environmental planning, are exempt from environmental studies.

2.4.4. Aircraft Noise Studies. AICUZ and ICUZ are programs initiated to implement Federal laws concerning land compatibility from the perspective of environmental noise impacts. The ICUZ program is the Army's extension of the AICUZ which was initiated by DoD and undertaken primarily by Air Force and Navy aviation facilities. Studies under these programs establish noise abatement measures which help to eliminate or reduce the intensity of noise from its sources, and provide land use management measures for areas nearby the noise source.

2.4.4.1. Analysis. Due to the widely varied aircraft, aircraft power plants, airfield traffic volume, and airfield traffic patterns, aviation noise at installations depends upon both aircraft types and operational procedures. Aircraft noise studies should be prepared for aviation facilities to quantify noise levels and possible adverse environmental effects, ensure that noise reduction procedures are investigated, and plan land for uses which are compatible with higher levels of noise. While many areas of an aviation facility tolerate higher noise levels, many aviation landside facilities and adjoining properties do not. Noise contours developed under the AICUZ and ICUZ studies are used to graphically illustrate noise levels and provide a basis for land use management and impact mitigation. The primary means of noise assessment is mathematical modeling and computer simulation. Guidance regarding when to conduct noise studies is contained in the environmental directive for each service.

2.4.4.1.1. Fixed-Wing Aircraft Noise. Fixed-wing aircraft noise levels generated at aviation facilities are modeled using the current version of the NOISEMAP computer model. Of particular interest to facility planning for fixed-wing aircraft facilities is the land near areas used for engine run-up and testing and those land areas below the extended approach-departure path of runways.

2.4.4.1.2. Rotary-Wing Noise. Rotary-wing aircraft create a different class of noise which is described as having high-level, low-frequency energy. These noise levels create vibrations which vary greatly from that generated by fixed-wing aircraft. Helicopter noise measurement and modeling is primarily an Army initiative, and the latest modeling techniques for assessing rotary-wing aircraft noise is contained in NOISEMAP or the Helicopter Noise Model (HNM) computer noise program.

2.4.4.1.3. Noise Contour Maps. Noise levels generated from the activities of fixed- and rotary-wing operations are identified using contours which delineate areas of equal sound pressure impact on the areas surrounding the source of the noise. Noise levels are expressed in Ldn and noise contours provide a quantified diagram of the noise levels. Noise contours are illustrated on airfield general site plans, Installation Land Use Compatibility Plans, and/or Base Comprehensive Plans. Noise contours from other sources, such as firing ranges, should also be shown on the noise contour map. In addition, the noise contour maps should show the imaginary airspace such as the runway primary surface, clear zone, APZ 1, and APZ 2. Through the establishment of noise contour maps, potential noise sensitive areas on and off the aviation facility will be identified.

2.4.4.3. Requirement For Analysis of Noise Impact. An Environmental Impact Statement is required to analyze a noise impact. An EA is required when: (1) a project or facility is proposed within a noise sensitive area; (2) there is a change in flight operational procedures; or (3) the quality of the human environment is significantly affected by a change in aircraft noise.

2.4.5. Instrumented Runway Studies. The requirement to conduct an instrumented runway study is issued by the functional proponent. It is important to recognize that instrument landing capability provides for aircraft approaches at very low altitude ceilings or visibility distance minimums. Consequently, these lower approach minimums demand greater safety clearances, larger approach surfaces, and greater separation from potential obstacles or obstructions to air navigation.

2.5. Siting Aviation Facilities:

NOTE: While the general siting principles below are applicable to Navy aviation facilities, see MIL-HDBK-1021/1, *General Concepts for Airfield Pavement Design*, and NAVFAC P-80 for Navy-specific data and contacts.

2.5.1. Location. The general location of an aviation facility is governed by many factors, including base conversions, overall defense strategies, geographic advantages, mission realignment, security, and personnel recruitment. These large-scale considerations are beyond the scope of this manual. The information in this chapter provides guidelines for siting aviation facilities where the general location has been previously defined.

2.5.2. Site Selection:

2.5.2.1. Site Conditions. Site conditions must be considered when selecting a site for an aviation facility. The site considerations include, but are not limited to: topography, vegetative cover, existing construction, weather elements, wind direction, soil conditions, flood hazard, natural and man-made obstructions, adjacent land use, availability of usable airspace, accessibility of roads and utilities, and future expansion capability.

2.5.2.2. Future Development. Adequate land for future aviation growth must be considered when planning an aviation facility. An urgent requirement for immediate construction should not compromise the plan for future development merely because a usable, but not completely satisfactory, site is available. Hasty acceptance of an inferior site can preclude the orderly expansion and development of permanent facilities. Initial land acquisition (fee or lease) or an aviation easement of adequate area will prove to be the greatest asset in protecting the valuable airfield investment.

2.5.2.3. Sites not on DoD Property. Site selection for a new airfield or heliport not located on DoD or service controlled property must follow FAA planning criteria and each service's established planning processes and procedures for master planning as previously discussed in paragraph 2.4.1. Siting the aviation facility requires an investigation into the types of ground transportation that will be required, are presently available, or are capable of being implemented. All modes of access and transportation should be considered, including other airports/airfields, highways, railroads, local roadways, and internal roads. The facility's internal circulation plan should be examined to determine linear routes of movement by vehicles and pedestrians to ensure that an adequate access plan is achievable.

2.5.3. Airspace Approval. Construction of new airfields, heliports, helipad or hoverpoints, or modifications to existing facilities affecting the use of airspace or changes in aircraft densities will require notification to the Administrator, FAA, in conformance with AR 95-2, *Air Traffic Control, Air Space, Airfield Flight Facilities and Navigational Aids*. Copies of FAA airspace approval actions should normally accompany any construction projects when forwarded to Department of the Army (DA) for approval.

2.5.4. Airfield Safety Clearances:

2.5.4.1. Dimensional Criteria. The dimensions for airfield facilities, airfield lateral safety clearances, and airspace imaginary surfaces are provided in Chapters 3 and 4 of this manual.

2.5.4.2. Air Force Missions at Army Facilities. Airfield flight safety clearances applicable to Army airfields which support Air Force cargo aircraft missions will be based upon an Army Class B airfield. This will be coordinated between the Army and the Air Force.

2.5.4.3. Prohibited Land Uses. Airfield airspace criteria prohibit certain land uses within the clear zone and Accident Potential Zones (APZ 1 and APZ 2). These activities include the storage and handling of munitions and hazardous materials, and live-fire weapons ranges. See AICUZ DoD Instruction 4165.57 for more information.

2.5.4.4. Wake Turbulence. The problem of wake turbulence may be expected at airfields where there is a mix of light and heavy aircraft. At these airfields, some taxiway and holding apron design modifications may help to alleviate the hazards. Although research is underway to improve detection and elimination of the wake, at the present time, the most effective means of avoiding turbulent conditions is provided by air traffic control personnel monitoring and regulating both air and ground movement of aircraft. Planners can assist this effort by providing the controllers line-of-site observation to all critical aircraft operational areas and making allowances for aircraft spacing and clearances in turbulence prone areas. Additional information on this subject is available in FAA AC 90-230, *Wake Turbulence*.

2.6. Airside and Landside Facilities. An aviation facility consists of four land use areas. They are:

2.6.1. Airside Facilities:

2.6.1.1. Landing and take-off area.

2.6.1.2. Aircraft ground movement and parking areas.

2.6.2. Landside Facilities:

2.6.2.1. Aircraft maintenance areas.

2.6.2.2. Aviation operations support areas.

2.7. Landing and Takeoff Area:

2.7.1. Runways and Helipads. Take-off and landing areas are based on either a runway or helipad. The landing/take-off area consists not only of the runway and helipad surface, shoulders, and overruns, but also approach slope surfaces, safety clearances and other imaginary airspace surfaces.

2.7.2. Number of Runways. Aviation facilities normally have only one runway. Additional runways may be necessary to accommodate operational demands, minimize adverse wind conditions or overcome environmental impacts. A parallel runway may be provided based on operational requirements. Methodologies for calculating runway capacity in terms of annual service volume (ASV) and hourly instrument flight rules (IFR) or visual flight rules (VFR) capacity are provided in FAA AC 150/5060-5, *Airport Capacity and Delay*. Planning efforts to analyze the need for more than one runway should be initiated when it is determined that traffic demand for the primary runway will reach 60 percent of its established capacity (FAA guidance).

2.7.3. Number of Helipads. The number of helipads authorized is discussed in Attachment 3. At times there are situations at airfields or heliports when a large number of helicopters are parked on mass aprons or are in the process of take-off and landing. When this occurs, there is usually a requirement to provide landing and take-off facilities that permit more rapid launch and recovery operations than can otherwise be provided by a single runway or helipad. This increased efficiency can be obtained by providing one or more of the following, but is not necessarily limited to:

2.7.3.1. Multiple helipads, hoverpoints, or runways.

2.7.3.2. Rotary-wing runways in excess of 240 meters (800 feet) long.

2.7.3.3. Landing lane(s).

2.7.4. Runway Location. Runway location and orientation are paramount to airport safety, efficiency, economics, practicality, and environmental impact. The degree of concern given to each factor influencing runway location depends greatly on meteorological conditions, adjacent land use and land availability, airspace availability, runway type/instrumentation, environmental factors, terrain features/topography, and obstructions to air navigation.

2.7.4.1. Obstructions to Air Navigation. The runway must have approaches which are free and clear of obstructions. Runways must be planned so that the ultimate development of the airport provides unobstructed navigation. A survey of obstructions should be undertaken to identify those objects which may affect aircraft operations. Protection of airspace can be accomplished through purchase, easement, zoning coordination, and application of appropriate military directives.

2.7.4.2. Airspace Availability. Existing and planned instrument approach procedures, control zones, and special use airspace and traffic patterns influence airfield layouts and runway locations. Construction projects for new airfields and heliports or construction projects on existing airfields have potential to affect airspace. These projects require notification to the FAA to examine feasibility for conformance with and acceptability into the national airspace system.

2.7.4.3. Runway Orientation. Wind direction and velocity is a major consideration for siting runways. To be functional, efficient, and safe, the runway should be oriented in alignment with the prevailing winds, to the greatest extent practical, to provide favorable wind coverage. Wind data, obtained from local sources, for a period of not less than five years, should be used as a basis for development of the windrose to be shown on the airfield general site plan. Attachment 5 provides guidance for the research, assessment, and application of wind data.

2.7.5. Runway and Helipad Separation. The lateral separation of a runway from a parallel runway, parallel taxiway, or helipad/hoverpoint is based on the type of aircraft the runway serves. Runway and helipad separation criteria are presented in Chapters 3 and 4 of this manual.

2.7.6. Runway Instrumentation. Navigational aids require land areas of specific size, shape, and grade to function properly and remain clear of safety areas.

2.7.6.1. Navigational Aids (NAVAIDS), Vault, and Buildings. NAVAIDS assist the pilot in flight and during landing. Technical guidance for flight control between airfields may be obtained from the U.S. Army Aeronautical Services Agency. The type of air navigational aids which are installed at an aviation facility are based on the instrumented runway studies, as previously discussed. A lighting equipment vault is provided for airfields and heliport facilities with navigational aids, and may be required at remote or stand-alone landing sites. A (NAVAID) building will be provided for airfields with navigational aids. Each type of NAVAID equipment is usually housed in a separate facility. Technical advice and guidance for air navigational aids should be obtained from the support and siting agencies listed in Attachment 17.

2.8. Aircraft Ground Movement and Parking Areas. Aircraft ground movement and parking areas consist of taxiways and aircraft parking aprons.

2.8.1. Taxiways. Taxiways provide for free ground movement to and from the runways, helipads, maintenance, cargo/passenger, and other areas of the aviation facility. The objective of taxiway system planning is to create a smooth traffic flow. This system allows unobstructed ground visibility; a minimum number of changes in the aircraft's taxiing speed; and, ideally, the shortest distance between the runways or helipads and apron areas.

2.8.1.1. Taxiway System. The taxiway system is comprised of entrance and exit taxiways; bypass, crossover taxiways; apron taxiways and taxilanes; hangar access taxiways; and partial-parallel, full-parallel, and dual-parallel taxiways. The design and layout dimensions for various taxiways are provided in Chapter 5.

2.8.1.2. Taxiway Capacity. At airfields with high levels of activity, the capacity of the taxiway system can become the limiting operational factor. Runway capacity and access efficiency can be enhanced or improved by the installation of parallel taxiways. A full length parallel taxiway may be provided for a single runway with appropriate connecting lateral taxiways to permit rapid entrance and exit of traffic between the apron and the runway. At facilities with low air traffic density, a partial parallel taxiway or mid length exit taxiway may suit local requirements. However, develop plans so that a full parallel taxiway may be constructed in the future when it can be justified.

2.8.1.3. Runway Exit Criteria. The number, type, and location of exit taxiways is a function of the required runway capacity. Exit taxiways are typically provided at the ends and in the center and mid-point on the runway. Additional locations may be provided as necessary to allow landing aircraft to exit the runway quickly. Additional information on exit taxiways may be found in Chapter 5.

2.8.1.4. Dual-Use Facility Taxiways. For taxiways at airfields supporting both fixed-wing and rotary-wing operations, the appropriate fixed-wing criteria should be applied.

2.8.1.5. Paved Taxiway Shoulders. Paved taxiway shoulders are provided to reduce the effects of jet blast on areas adjacent the taxiway. Paved taxiway shoulders help reduce ingestion of foreign objects debris (FOD) into jet intakes. Paved shoulders will be provided on taxiways in accordance with the requirements set forth in Chapter 5 and Attachment 3.

2.8.2. Aircraft Parking Aprons. Aircraft parking aprons are the paved areas required for aircraft parking, loading, unloading, and servicing. They include the necessary maneuvering area for access and exit to parking positions. Aprons will be designed to permit safe and controlled movement of aircraft under their own power. Aircraft apron dimensions and size are based on mission requirements. Additional information concerning Air Force aprons is found in AFH 32-1084, Section D, *Apron Criteria*.

2.8.2.1. Requirement. Aprons are individually designed to support specific aircraft and missions at specific facilities. The size of a parking apron is dependent upon the type and number of aircraft authorized. Chapter 6 provides additional information on apron requirements.

2.8.2.2. Location. Aircraft parking aprons typically are located between the parallel taxiway and the hangar line. Apron location with regard to airfield layout will adhere to operations and safety clearances provided in Chapter 6 of this manual.

2.8.2.3. Capacity. Aircraft parking capacity for the Army is discussed in Attachment 3 of this manual; in NAVFAC P-80 for the Navy; and AFH 32-1084 for the Air Force.

2.8.2.4. Clearances. Lateral clearances for parking aprons are provided from all sides of aprons to fixed and/or mobile objects. Additional information on lateral clearances for aprons is discussed in Chapter 6.

2.8.2.5. Access Taxilanes, Entrances, and Exits. The dimensions for access taxilanes on aircraft parking aprons are provided in Chapter 6. The minimum number of exit/entrance taxiways provided for any parking apron should be two (2).

2.8.2.6. Aircraft Parking Schemes. On a typical mass parking apron, aircraft should be parked in rows. The recommended tactical/fighter aircraft parking arrangement is to park aircraft at a 45-degree angle. This is the most economical parking method for achieving the clearance needed to dissipate jet blast temperatures and velocities to levels that will not endanger aircraft or personnel. (For Navy, these are 38 ºC (100 ºF) and 56 kmh (35 mph) at break-away (intermediate power)). Typical parking arrangements and associated clearances are provided in Chapter 6.

2.8.2.7. Departure Sequencing. Formal aircraft egress patterns from aircraft parking positions to the apron exit taxiways should be established to prevent congestion at the apron exits. For example, aircraft departing from one row of parking positions should taxi to one exit taxiway, allowing other rows to simultaneously taxi to a different exit.

2.8.2.8. Army and Navy Aprons. Army aircraft parking aprons are divided into three categories: unit, general purpose, and special purpose. The category to be provided is based on the mission support requirement of the facility.

2.8.2.8.1. Unit Parking Apron. The unit parking category supports fixed- and rotary-wing aircraft assigned to the facility.

2.8.2.8.2. General Purpose Apron. When no tenant units are assigned to an aviation facility, and transient aircraft parking is anticipated, a personnel loading apron or aircraft general purpose apron should be provided in lieu of a mass parking apron.

2.8.2.8.3. Special Purpose Apron. Special purpose aprons are provided for specific operations such as providing safe areas for arming/disarming aircraft and other specific mission requirements that demand separation of or distinct handling procedures for aircraft.

2.8.2.9. Apron/Other Pavement Types. Special use aprons may exist on an aviation facility. Further information on these aprons/pavements may be found in Chapter 6.

2.9. Aircraft Maintenance Area (Other than Pavements). An aircraft maintenance area is required when aircraft maintenance must be performed regularly at an aviation facility. Space requirements for maintenance facilities are based on aircraft type.

2.9.1. Aircraft Maintenance Facilities. The aircraft maintenance facility includes, but is not limited to: aircraft maintenance hangars, special purpose hangars, hangar access aprons, weapons system support shops, aircraft system testing and repair shops, aircraft parts storage, corrosion control facilities, and special purpose maintenance pads. The aircraft maintenance area includes utilities, roadways, fencing, and security facilities and lighting.

2.9.2. Aviation Maintenance Buildings (Air Force and Navy). For aviation maintenance building information for the Air Force, see AFH 32-1084; for the Navy, see MIL HDBK 1028/1, *Aircraft Maintenance Facilities*.

2.9.3. Aviation Maintenance Buildings (Army):

2.9.3.1. Maintenance Hangars. Maintenance hangars are required to support those aircraft maintenance, repair, and inspection activities which can be more effectively accomplished while the aircraft is under complete cover. The size requirement for maintenance hangars is determined by the number of aircraft assigned.

2.9.3.2. Security and Storage Hangars. These hangars are limited in use and do not require the features normally found in maintenance hangars.

2.9.3.3. Avionics Maintenance Shop. Avionics maintenance space should normally be provided within the maintenance hangar. However, a separate building for consolidated avionics repair may be provided at aviation facilities with multiple units.

2.9.3.4. Engine Repair and Engine Test Facilities. Engine repair and test facilities are provided at air bases with aircraft engine removal, repair, and testing requirements. Siting of engine test facilities should consider the impacts of jet blast, jet blast protection, and noise suppression.

2.9.3.5. Parts Storage. Covered storage of aircraft parts should be provided at all aviation facilities and located close enough to the maintenance area to allow easy access to end-users.

2.9.4. Maintenance Aprons. These aprons should be sized according to the dimensions discussed in Chapter 6.

2.9.5. Apron Lighting. Apron area lighting (floodlights) is provided where aircraft movement, maintenance, and security are required at night, and during poor visibility. Type of lighting is based on the amount of apron space or number of aircraft positions which receive active use during nighttime operations.

2.9.6. Security. The hangar line typically represents the boundary of the airfield operations area. Maintenance buildings should be closely collocated to discourage unauthorized access and enhance facility security.

2.10. Aviation Operations Support Area:

2.10.1. Aviation Operations Support Facilities. Aviation operations support facilities include those facilities that directly support the flying mission. Operations support includes air traffic control, aircraft rescue and firefighting, fueling facilities, airfield operations center (airfield management facility), squadron operations/aircraft maintenance units, and air mobility operations groups.

2.10.2. Location. Aviation operations support facilities should be located along the hangar line with the central area typically being allocated to airfield operations (airfield management facility), air traffic control, aircraft rescue and firefighting, and flight simulation. Aircraft maintenance facilities should be located on one side of the runway to allow simplified access among maintenance areas, aircraft, and support areas.

2.10.3. Orientation of Facilities. Facilities located either parallel or perpendicular to the runway make the most efficient use of space. Diagonal and curved areas tend to chop up the area and result in awkward or unusable spaces.

2.10.4. Multiple Supporting Facilities. When multiple aviation units are located at one facility, their integrity may be retained by locating such units adjacent to each other.

2.10.5. Transient Facilities. Provisions should be made for transient and VIP aprons and buildings. These facilities should be located near the supporting facilities discussed above.

2.10.6. Other Support Facilities. When required, other support facilities, such as aviation fuel storage and dispensing, heating plants, water storage, consolidated parts storage, and motor pool facilities should be sited on the far side of an access road paralleling the hangar line.

2.10.6.1. Air Traffic Control Facilities. The siting and height of the ATC tower cab is determined by an operational assessment conducted by USAATCA and ATZQ-ATC-A (U.S. Army Air Traffic Control Activity), and in accordance with MIL-HDBK 1024/1, *Aviation Operational and Support Facilities* (Navy and Marine Corps). Air Force ATC towers are sited in accordance with Attachment 18.

2.10.6.2. Radar Buildings. Some airfields are equipped with radar capability. When the functional proponent determines the need for radar capability, space for radar equipment will be provided. Space for radar equipment should be provided in the flight control tower building.

2.10.6.3. Aircraft Rescue and Fire Facilities. Airfield facilities and flight operations will be supported by fire and rescue equipment. The aircraft rescue and fire facilities must be located strategically to allow aircraft firefighting vehicles to meet response time requirements to all areas of the airfield. Coordinate the airfield fire and rescue facility and special rescue equipment with the facility protection mission and Master Plan. It may be economically sound to develop a consolidated or expanded facility to support both airside and landside facilities. The site of the fire and rescue station must permit ready access of equipment to the aircraft operational areas and the road system serving the airfield facilities. A site centrally located, close to the midpoint of the runway, and near the airfield operations area (airfield management and base operations building (Air Force)) and air traffic control tower is preferred.

2.10.6.4. Rescue and Ambulance Helicopters. With the increasing use of helicopters for emergency rescue and air ambulance service, consideration should be given to providing an alert helicopter parking space near the fire and rescue station. This space may be located as part of the fire and rescue station or in a designated area on an adjacent aircraft parking apron.

2.10.6.5. Hospital Helipad. A helipad should normally be sited in close proximity to each hospital to permit helicopter access for emergency use. Subject to necessary flight clearances and other hospital site factors, the hospital helipad should permit reasonably direct access to and from the hospital emergency entrance.

2.10.6.6. Miscellaneous Buildings. The following buildings should be provided as part of an aviation facility. Authorization and space allowances should be determined in accordance with directives for each branch of service.

2.10.6.6.1. Airfield operations building (airfield management facility).

2.10.6.6.2. Aviation unit operations building (Army); squadron operations building (Air Force).

2.10.6.6.3. Representative weather observation stations (RWOS).

2.10.7. Aircraft Fuel Storage and Dispensing:

2.10.7.1. Location. Aircraft fuel storage and dispensing facilities will be provided at all aviation facilities. Operating fuel storage tanks will be provided wherever dispensing facilities are remote from bulk storage. Bulk fuel storage areas require locations which are accessible by tanker-truck, tanker-rail car, or by waterfront. Both bulk storage and operating storage areas must provide for the loading and parking of fuel vehicles to service aircraft. Where hydrant fueling systems are authorized, bulk fuel storage locations must take into account systems design requirements (e.g., the distance from the fueling apron to the storage tanks).

2.10.7.2. Safety. Fuel storage and operating areas have requirements for minimum clearances from buildings, aircraft parking, roadways, radar, and other structures/areas, as established in service directives. Aviation fuel storage and operating areas also require lighting, fencing, and security alarms. All liquid fuel storage facility sitings must address spill containment and leak protection/detection.

2.10.8. Roadways to Support Airfield Activities:

2.10.8.1. General. Vehicular roads on airfields should not cross or be within the lateral clearance distance for runways, high-speed taxiways, and dedicated taxiways for alert pads. This will prevent normal vehicular traffic from obstructing aircraft in transit. Roads should be located so that surface vehicles will not be hazards to air navigation and air navigation equipment.

2.10.8.2. Rescue and Firefighting Roadways. Rescue and firefighting access roads are usually needed to provide unimpeded two-way access for rescue and firefighting equipment to potential accident areas. Connecting these access roads to the extent practical with airfield operational surfaces and other airfield roads will enhance fire and rescue operations. Dedicated rescue and firefighting access roads are all-weather roads designed to support vehicles traveling at normal response speeds.

2.10.8.3. Fuel Truck Access. Fuel truck access points to aircraft parking aprons should be located to provide minimal disruptions and hazards to active aircraft movement areas. Fuel truck access from the facility boundary to the fuel storage areas should be separate from other vehicular traffic. Fuel trucks should be parked as close to the flight line as reasonably possible.

2.10.8.4. Explosives and Munitions Transfer to Arm/Disarm Pads. Transfer of explosives and munitions from storage areas to arm/disarm pads should occur on dedicated transfer roads. Transfer roads should be used exclusively for explosives and munitions transfer vehicles.

Chapter 3

RUNWAYS (FIXED-WING) AND IMAGINARY SURFACES

3.1. Contents. This chapter presents design standards and considerations for fixed-wing runways and associated imaginary surfaces.

3.2. Requirements. The landing and take-off design considerations for an airfield include mission requirements, expected type and volume of air traffic, traffic patterns such as the arrangement of multidirectional approaches and takeoffs, ultimate runway length, runway orientation required by local wind conditions, local terrain, restrictions due to airspace obstacles or surrounding community, noise impact, and aircraft accident potential.

3.3. Runway Classification. Runways are classified as either Class A or Class B, based on aircraft type as shown in Table 3.1. This table uses the same runway classification system established by the Office of the Secretary of Defense as a means of defining accident potential areas (zones) for the Air Installations Compatible Use Zones (AICUZ) Program. These runway classes are not to be confused with aircraft approach categories and aircraft wingspan in other DoD or FAA documents, aircraft weight classifications, or pavement traffic areas. The aircraft listed provide examples of aircraft which fall into these classifications and may not be all inclusive.

Table 3.1. Runway Classification by Aircraft Type.

Class A Runways		Class B Runways		
C-1	OV-1	A-6	C-141	P-3
C-2	T-3A	A-10	E-3	S-3
C-12	T-28	AV-8	E-4	SR-71
C-20	T-34	B-1	E-6	T-1
C-21	T-44	B-2	R/F-4	T-2
C-23	U-21	B-52	F-5	T-37
C-26	UV-18	C-5	F-14	T-38
E-1	DASH-7	C-9	F-15	T-39
E-2	DASH-8	KC-10	F-16	T-42
		C-17	F/A-18	T-45
		C-130	F-22	TR-1
		C-135	FB-111	U-2
		C-137	F-117	

Notes:

1. Only symbols for basic mission aircraft or basic mission aircraft plus type are used. Designations represent entire series. Runway classes in this table are not related to aircraft approach categories, aircraft weight, aircraft wingspan, or to pavement design classes or types.
2. These are examples of aircraft which fall into these classifications, and may not be all inclusive.
3. Rotary aircraft are not addressed in this table.
4. V-22 aircraft is a rotary aircraft which operates as a rotary-wing aircraft on a Class A runway and operates as either a fixed-wing or rotary-wing aircraft on taxiways associated with Class A runways.

3.3.1. Class A Runways. Class A runways are primarily intended for small light aircraft. These runways do not have the potential or foreseeable requirement for development for use by high performance and large heavy aircraft. Ordinarily, these runways are less than 2,440 meters [8,000 feet] long and have less than 10 percent of their operations that involve aircraft in the Class B category.

3.3.2. Class B Runways. Class B runways are primarily intended for high performance and large heavy aircraft, as shown in Table 3.1.

3.3.3. Rotary-Wing and V-STOL Aircraft. Runways for Rotary-wing and Vertical Take-Off and Landing (V-STOL) (V-22) aircraft are not addressed in this chapter. Design standards and considerations for rotary-wing aircraft runways and landing lanes are found in Chapter 4 of this manual. Information on the design standards and considerations for the V-STOL aircraft may be obtained from:

Department of the Navy
LANTDIV Code 15C
1510 Gilbert St.
Norfolk, VA 23511-2699

3.3.4. Army Airfields Class A and Class B Criteria. For Army airfields where Air Force aircraft may not normally operate, the runway will be designed with Class A criteria. For Army airfields where Air Force transport aircraft may operate, the runway will be designed with Class B criteria, except for lateral clearances and some other selected primary surface criteria, as noted in the tables. These dimensional changes are to provide the installation with Air Force support, while not jeopardizing the mission.

3.3.5. Short Fields and Training Assault Landing Zones. Short Fields and Training Assault Landing Zones are special use fields. Design criteria are found in Air Force Engineering Technical Letter (ETL) 98-5, *C-130 and C-17 Contingency and Training Airfield Criteria*. When fully developed and approved, criteria for training airfields will be provided in Chapter 7 of this manual.

3.4. Runway Systems. As discussed in Chapter 2, an airfield normally has only one runway.

3.4.1. Single Runway. A single runway is the least flexible and lowest capacity system. The capacity of a single runway system will vary from approximately 40 to 50 operations per hour under IFR conditions, up to 75 operations per hour under VFR conditions.

3.4.2. Parallel Runways. Parallel runways are the most commonly used system for increased capacity. In some cases, parallel runways may be staggered with the runway ends offset from each other and with terminal or service facilities located between the runways. When parallel runways are separated by less than the distance shown in Item 15 of Table 3.2, the second runway will increase capacity at the airfield under VFR conditions, but due to the close distance, capacity at the airfield will not be increased under IFR conditions.

3.4.3. Crosswind Runways. Crosswind runways may be either the open-V or the intersecting type of runway. The crosswind system is adaptable to a wider variety of wind conditions than the parallel system. When winds are calm, both runways may be used simultaneously. An open-V system has a greater capacity than the intersecting system.

3.5. Runway Orientation/Wind Data. Runway orientation is the key to a safe, efficient, and usable aviation facility. Orientation is based on an analysis of wind data, terrain, local development, operational procedures and other pertinent data. Procedures for analysis of wind data to determine runway orientation are further discussed in attachment 4.

NOTE*:* Metric units apply to new airfield construction, and where practical, to modifications to existing airfields and heliports, as discussed in paragraph 1.4.4.

Table 3.2. Runways.

Item No.	Item Description	Class A Runway	Class B Runway	Remarks
		Requirement		
1	Length	See Table 3.3	See Remarks	For Army airfields. For Army Class B runways, runway length will be determined by the Air Force MAJCOM for the most critical aircraft in support of the mission.
		See Remarks	See Remarks	For Air Force airfields, runway length will be determined by the MAJCOM for the most critical aircraft in support of the mission.
		See Remarks	See Remarks	For Navy and Marine Corps airfields, see NAVFAC P-80 for computation of runway lengths.
2	Width	30 m [100 ft]	46 m [150 ft]	Army airfields and Air Force airfields, not otherwise specified.
		NA	90 m [300 ft]	B-52 aircraft.
		23 m [75 ft]	N/A	Navy and Marine Corps class A runways. Runway width for T-34 and T-44 will be 45 m [150 ft].
		NA	60 m [200 ft]	Navy and Marine Corps airfields.
3	Total width of shoulders (paved and unpaved)	15 m [50 ft]	60 m [200 ft]	Army and Air Force airfields.
		7.5 m [25 ft]	46 m [150 ft]	Navy and Marine Corps airfields.
4	Paved shoulder width	7.5 m [25 ft]	7.5 m [25 ft]	Army airfields, and Air Force airfields not otherwise specified below.
		NA	3 m [10 ft]	Air Force airfields designed for Trainer, Fighter and B-52 aircraft.
		3 m [10 ft]	3 m [10 ft]	Navy and Marine Corps airfields.

<table>
<tr><td>5</td><td>Longitudinal grades of runway and shoulders</td><td colspan="2">Maximum 1.0%</td><td>Grades may be both positive and negative but must not exceed the limit specified.

Exception for shoulders: a 3.0 percent maximum is permitted where arresting barriers are installed.</td></tr>
<tr><td>6</td><td>Longitudinal runway grade changes</td><td>No grade change is to occur less than 300 m [1,000 ft] from the runway end</td><td>No grade change is to occur less than 900 m [3,000 ft] from the runway end</td><td>Where economically feasible, the runway will have a constant centerline gradient from end to end. Where terrain dictates the need for centerline grade changes, the distance between two successive point of intersection (PI) will be not less than 300 m [1,000 ft] and two successive distances between PIs will not be the same.</td></tr>
<tr><td rowspan="3">7</td><td rowspan="3">Rate of longitudinal runway grade changes</td><td colspan="2">Max 0.167% per 30 linear meters [100 linear feet]of runway</td><td>For Army and Air Force.

Maximum rate of longitudinal grade change is produced by vertical curves having 180 meters [600 foot] lengths for each percent of algebraic difference between the two grades.</td></tr>
<tr><td colspan="2">Max 0.10% per 30 linear meters [100 linear feet] of runway</td><td>For Navy and Marine Corps.

Maximum rate of longitudinal grade change is produced by vertical curves having 300 meters [1,000 foot] lengths for each percent of algebraic difference between the two grades.</td></tr>
<tr><td colspan="2">See Remarks</td><td>Exceptions: 0.4 percent for edge of runways at runway intersections.</td></tr>
<tr><td>8</td><td>Longitudinal sight distance</td><td colspan="2">Min 1,500 m [5,000 ft]</td><td>Any two points 2.4 m [8 ft] above the pavement must be mutually visible (visible by each other) for the distance indicated.

For runways shorter than 1,500 meters [5,000 ft], height above runway will be reduced proportionally.</td></tr>
<tr><td rowspan="2">9</td><td rowspan="2">Transverse grade of runway</td><td rowspan="2" colspan="2">Min 1.0%
Max 1.5%</td><td>New runway pavements will be centerline crowned. Existing runway pavements with insufficient transverse gradients for rapid drainage should provide increasing gradients when overlaid or reconstructed.</td></tr>
<tr><td>Slope pavement downwards from centerline of runway.

1.5% slope is optimum transverse grade of runway.

Selected transverse grade is to remain constant for length of runway, except at or adjacent to</td></tr>
</table>

				runway intersections where pavement surfaces must be warped to match abutting pavements.
10	Transverse grade of paved shoulder	2% min 3% max		Paved Portion of Shoulder. Slope downward from runway pavement.
11	Transverse grade of unpaved shoulder	(a) 40 mm [1-1/2"] drop off at edge of paved shoulder (b) 5% slope first 3 m [10 ft] from paved shoulder and edge of runway without paved shoulder (c) beyond 3 m [10 ft] from paved shoulder and edge of runway without paved shoulder - 2% min, 4% max.		Unpaved Portion of Shoulder. Slope downward from shoulder pavement. For additional information, see Figure 3.1.
12	Runway lateral clearance zone	152.40 m [500 ft]	152.40 m [500 ft]	Army airfields.
		152.40 m [500 ft]	304.80 m [1,000 ft]	Air Force, Navy, and Marine Corps.
				The runway lateral clearance zone's lateral limits coincide with the limits of the primary surface. The ends of the lateral clearance zone coincide with the runway ends. The ground surface within this area must be clear of fixed or mobile objects, and graded to the requirements of Table 3.2, items 13 and 14. The zone width is measured perpendicularly from the centerline of the runway and begins at the runway centerline. In addition to the lateral clearance criterion, the vertical height restriction on structures and parked aircraft as a result of the 7 to 1 transitional slope must be taken into account. See Table 3.7, item 30. (1) Fixed obstacles include manmade or natural features such as buildings (including air traffic control towers), trees, rocks, terrain irregular-ities and any other features constituting possible hazards to moving aircraft. Navigational aids and meteorological equipment will be sited within these clearances where essential for their proper functioning to fulfill flight operation requirements. For Army and Air Force, this area to be clear of all obstacles except for the permissible deviations

				noted in Attachment 14. For Navy and Marine Corps, certain items that are listed in NAVFAC P-80.3 are exempted. (2) Mobile obstacles include parked aircraft, parked and moving vehicles, railroad cars, and similar equipment. Taxiing aircraft and emergency vehicles are exempt from this restriction. (3) For Army and Air Force airfields, parallel taxiway (exclusive of shoulder width) will be located in excess of the lateral clearance distances (Primary Surface). For Navy and Marine Corps airfields, the centerline of a parallel taxiway may be located at the lateral clearance distance (thus allowing a portion of the taxiway pavement to be within the primary surface). (4) For Class A runways, except at Navy and Marine Corps airfields, above ground drainage structures, including head wall, are not permitted within 76.2 meters [250 feet] of the runway edge. For Class B runways, except at Navy and Marine Corps airfields, above ground drainage structures, including head walls are not permitted within 91.44 meters [300 feet] from the runway edge. At Navy and Marine Corps airfields, above ground drainage structures will be individually reviewed. Drainage slopes of up to a 10 to 1 ratio are permitted for all runway classes, but swales with more gentle slopes are preferred. (5) Distance from runway centerline to helipads is discussed in Table 4.1. For Military installations overseas (other than bases located in the United States, its territories, trusts, and possessions), apply to the maximum practical extent.
		152.4 m (500 ft)	228.6 m (750 ft)	Navy airfields constructed prior to 1997.
13	Longitudinal grades within runway lateral clearance zone	Max 10.0%		Exclusive of pavement, shoulders, and cover over drainage structures. Slopes are to be as gradual as practicable. Avoid abrupt changes or sudden reversals. Rough grade to the extent necessary to minimize damage to aircraft. Grades must not penetrate the elevation of the

				primary surface. The elevation of any point on the primary surface is the same as the elevation of the nearest point on the runway centerline.
14	Transverse grades within runway lateral clearance zone (in direction of surface drainage)	Minimum of 2.0% prior to channelization* Max 10.0%		Exclusive of pavement, shoulders, and cover over drainage structures. Slopes are to be as gradual as practicable. Avoid abrupt changes or sudden reversals. Rough grade to the extent necessary to minimize damage to aircraft. Grades must not penetrate the elevation of the primary surface. The elevation of any point on the primary surface is the same as the elevation of the nearest point on the runway centerline.
15	Distance between centerlines of parallel runways	213.36 m [700 ft]	304.80 m [1,000 ft]	Visual flight rules (VFR) without intervening parallel taxiway between the parallel runways. One of the parallel runways must be a VFR only runway.
		632.46 m [2,075 ft]		VFR with intervening parallel taxiway.
		762.00 m [2,500 ft]		IFR using simultaneous operation (Depart-Depart) (Depart-Arrival).
		1,310.64 m [4,300 ft]		Instrument flight rules (IFR) using simultaneous approaches.
				For separation distance between fixed wing runways and rotary wing facilities, see Table 4.1.

* Bed of channel may be flat.

Notes:
1. Geometric design criteria in this manual are based on aircraft-specific requirements and are not direct conversions from inch-pound (English) dimensions. Inch-pound units are included only to permit reference to the previous standard.
2. Airfield and heliport imaginary surfaces and safe wingtip clearance dimensions are direct conversions from inch-pound to SI units.

3.6. Additional Considerations for Runway Orientation. In addition to meteorological and wind conditions, the following factors must be considered:

3.6.1. Obstructions. A specific airfield site and the proposed runway orientation must be known before a detailed survey can be made of obstructions which affect aircraft operations. Runways should be so oriented that approaches necessary for the ultimate development of the airfield are free of all obstructions.

3.6.2. Restricted Airspace. Airspace through which aircraft operations are restricted, and possibly prohibited, are shown on sectional and local aeronautical charts. Runways should be so oriented that their approach and departure patterns do not encroach on the restricted areas.

3.6.3. Built-Up Areas. Airfield sites and runway alignment will be selected and the operational procedures adopted which will least impact local inhabitants. Additional guidance for facilities is found in DoD Instruction 4165.57, *Air Installations Compatible Use Zone (AICUZ) Program*.

3.6.4. Neighboring Airports. Existing aircraft traffic patterns of airfields in the area may affect runway alignment.

3.6.5. Topography. Avoid sites which require excessive cuts and fills. Evaluate the effects of topographical features on: airspace zones, grading, drainage, and possible future runway extensions.

3.6.6. Soil Conditions. Evaluate soil conditions at potential sites to minimize settlement problems, heaving from highly expansive soils, high groundwater problems, and construction costs.

3.6.7. Noise Analysis. Noise analyses should be conducted to determine noise impacts to local communities and identify noise sensitive areas.

3.7. Runway Designation. Runways are identified by the whole number nearest one-tenth (1/10) the magnetic azimuth of the runway centerline. The magnetic azimuth of the runway centerline is measured clockwise from magnetic north when viewed from the direction of approach. For example, where the magnetic azimuth is 183 degrees, the runway designation marking would be 18; and for a magnetic azimuth of 117 degrees, the runway designation marking would be 12. For a magnetic azimuth ending in the number 5, such as 185 degrees, the runway designation marking can be either 18 or 19. Supplemental letters, where required for differentiation of parallel runways, are placed between the designation numbers and the threshold or threshold marking. For parallel runways, the supplemental letter is based on the runway location, left-to-right, when viewed from the direction of approach: for two parallel runways — "L", "R"; for three parallel runways — "L", "C", "R."

3.8. Runway Dimensions. The following paragraphs and tables present the design criteria for runway dimensions at all aviation facilities except Short Fields and Training Assault Landing Zones. The criteria presented in the tables are for all DoD components (Army, Air Force, Navy and Marine Corps) except where deviations are noted.

3.8.1. Runway Dimension Criteria, Except Runway Length. Table 3.2 presents all dimensional criteria, except runway length, for the layout and design of runways used primarily to support fixed-wing aircraft operation.

3.8.2. Runway Length Criteria:

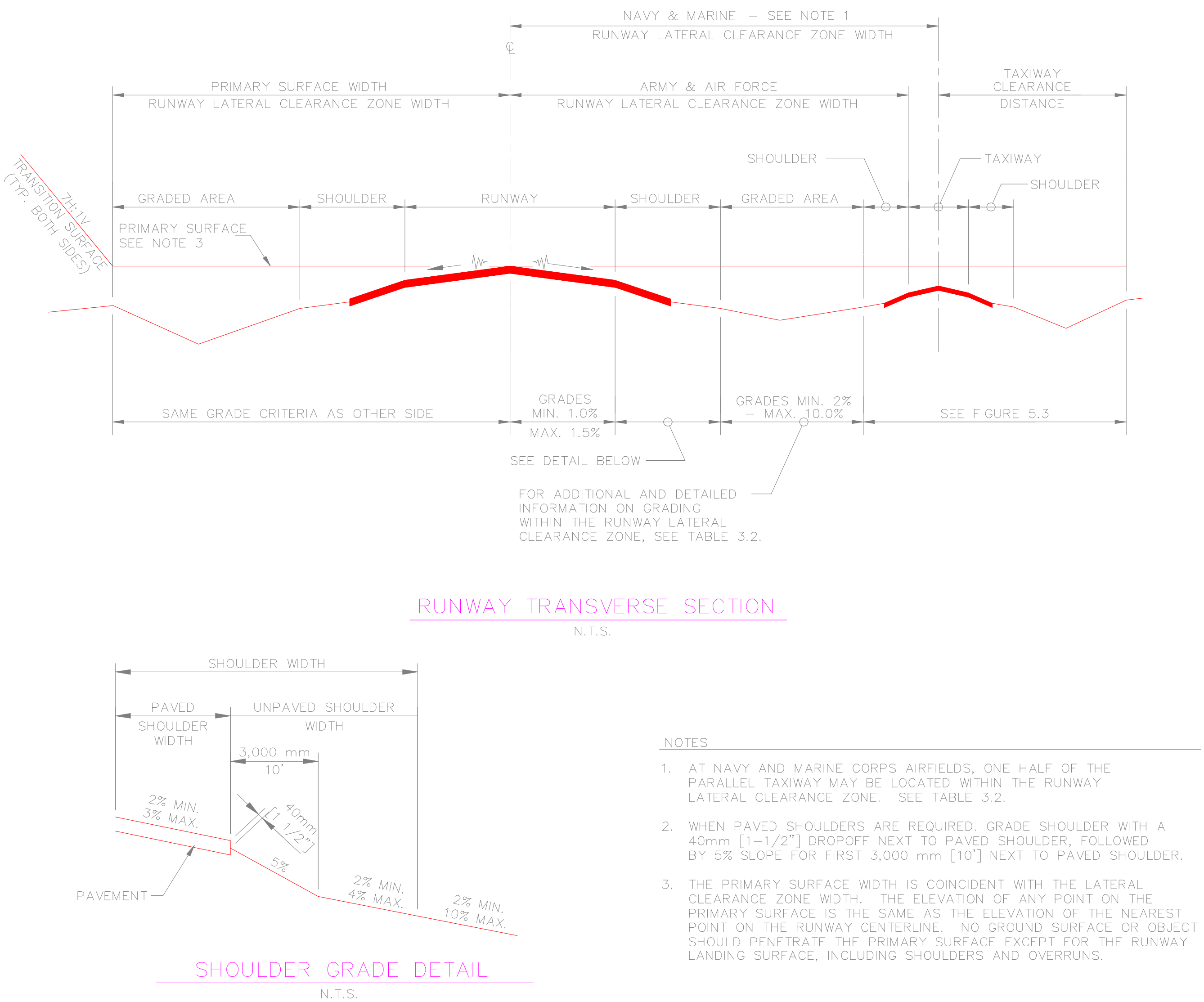
3.8.2.1. Army. For Army Class A runways, the runway length will be determined in accordance with Table 3.3. Army Class B runways are used by Air Force aircraft, and therefore will have the runway length determined by the Air Force MAJCOM.

3.8.2.2. Air Force. For Air Force Class A and Class B runways, the length will be determined by the MAJCOM.

3.8.2.3. Navy and Marine Corps. Runway length computation for Navy and Marine Corps Class A and Class B runways is presented in NAVFAC P-80.

3.8.3. Layout. Typical sections and profiles for Army, Air Force, Navy and Marine Corps airfield runways, including clear zones, are shown in Figures 3.1 through 3.19.

Figure 3.1. Runway Transverse Sections.

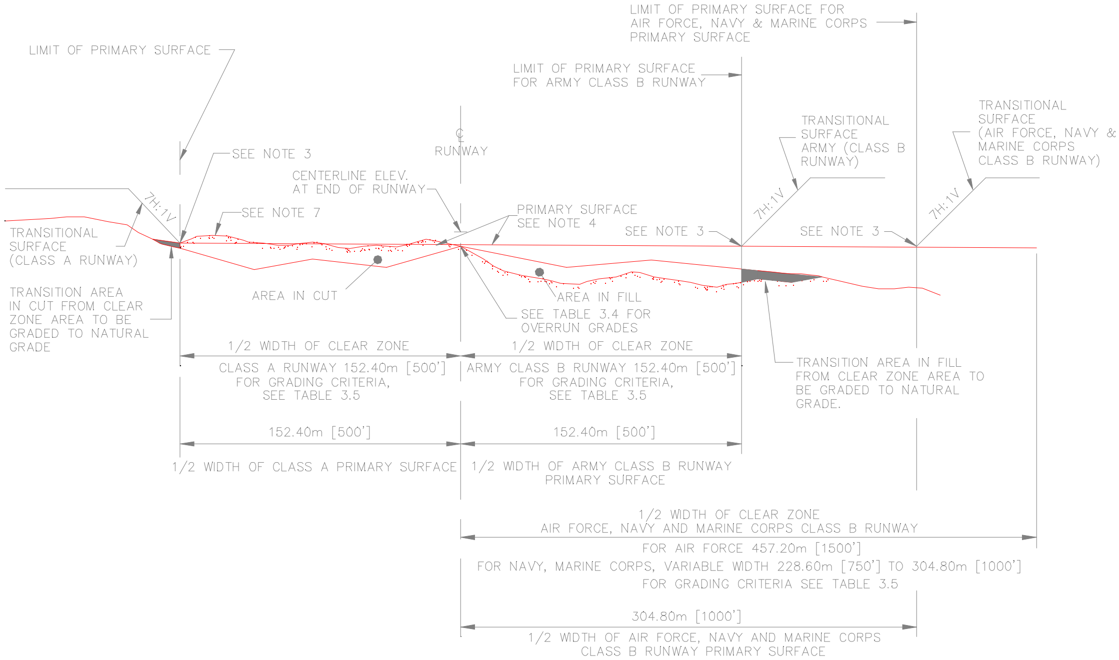


NOTES

1. AT NAVY AND MARINE CORPS AIRFIELDS, ONE HALF OF THE PARALLEL TAXIWAY MAY BE LOCATED WITHIN THE RUNWAY LATERAL CLEARANCE ZONE. SEE TABLE 3.2.
2. WHEN PAVED SHOULDERS ARE REQUIRED. GRADE SHOULDER WITH A 40mm [1–1/2"] DROPOFF NEXT TO PAVED SHOULDER, FOLLOWED BY 5% SLOPE FOR FIRST 3,000 mm [10'] NEXT TO PAVED SHOULDER.
3. THE PRIMARY SURFACE WIDTH IS COINCIDENT WITH THE LATERAL CLEARANCE ZONE WIDTH. THE ELEVATION OF ANY POINT ON THE PRIMARY SURFACE IS THE SAME AS THE ELEVATION OF THE NEAREST POINT ON THE RUNWAY CENTERLINE. NO GROUND SURFACE OR OBJECT SHOULD PENETRATE THE PRIMARY SURFACE EXCEPT FOR THE RUNWAY LANDING SURFACE, INCLUDING SHOULDERS AND OVERRUNS.

CLASS A AND CLASS B RUNWAYS

Figure 3.2. Clear Zone Transverse Section Detail.



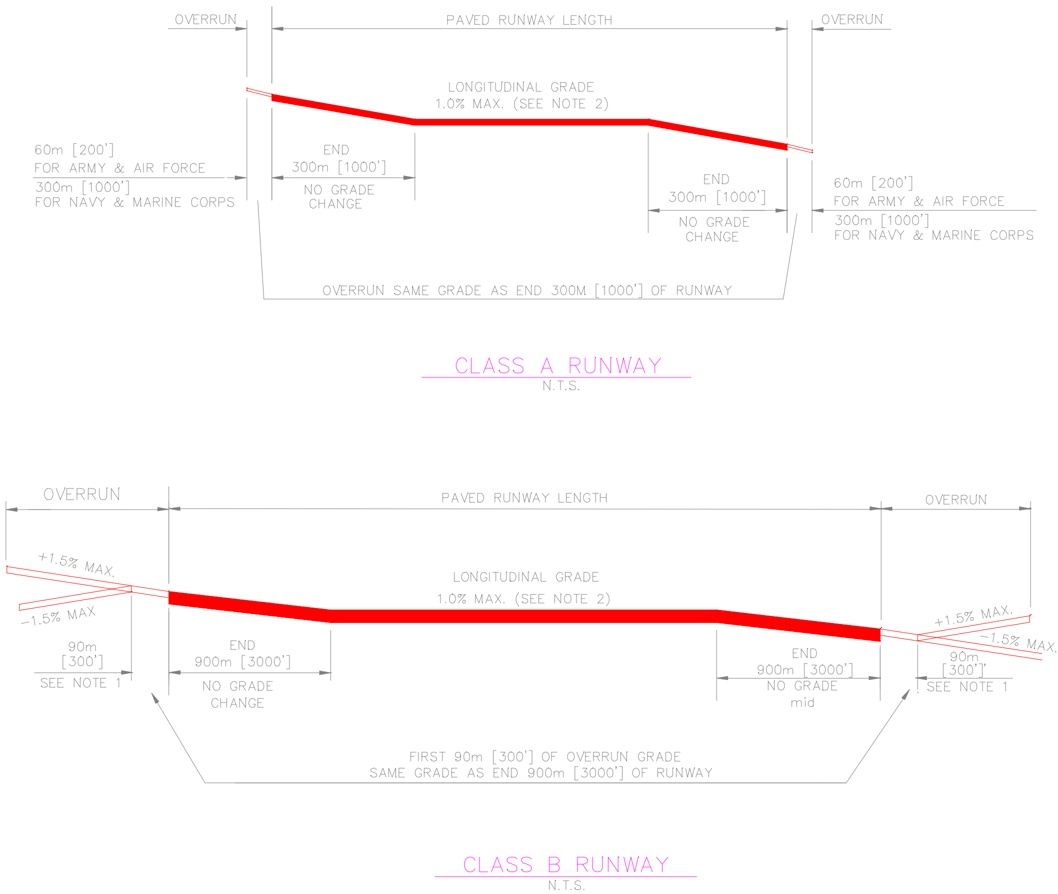
NOTES

1. TAKEN BEYOND END OF RUNWAY.
2. PRIMARY SURFACE APPLY ONLY TO FIRST 60.96m [200'] BEYOND END OF RUNWAY.
3. THE STARTING ELEVATION FOR THE 7:1 TRANSITIONAL SLOPE IS THE ELEVATION OF THE PRIMARY SURFACE ELEVATION. REFER TO TABLE 3.7.
4. ELEVATION OF ANY POINT ON THE PRIMARY SURFACE IS THE SAME AS THE ELEVATION OF THE NEAREST POINT ON THE RUNWAY CENTERLINE.
5. AT NAVY AND MARINE CORPS FACILITIES, THE PRIMARY SURFACE MAY BE 228.60m [750']
6. DISTANCES ARE SYMMETRICAL ABOUT CENTER OF RUNWAY.
7. NO GROUND SURFACE OR OBJECT CAN PENETRATE THE PRIMARY SURFACE OR THE TRANSITIONAL SURFACE.

HALF SECTION IN CUT

HALF SECTION IN FILL

Figure 3.3. Runway and Overrun Longitudinal Profile.

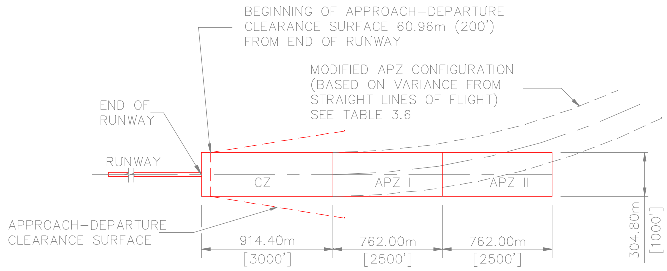


NOTES

1. TO AVOID ABRUPT CHANGES IN GRADE BETWEEN THE FIRST 90m [300'] OF THE OVERRUN AND THE REMAINDER OF THE OVERRUN, THE MAXIMUM CHANGE OF GRADE IS 2.0% PER 30m [100 L.F.].

2. GRADE MAY BE POSITIVE OR NEGATIVE BUT MUST NOT EXCEED THE LIMIT SPECIFIED.

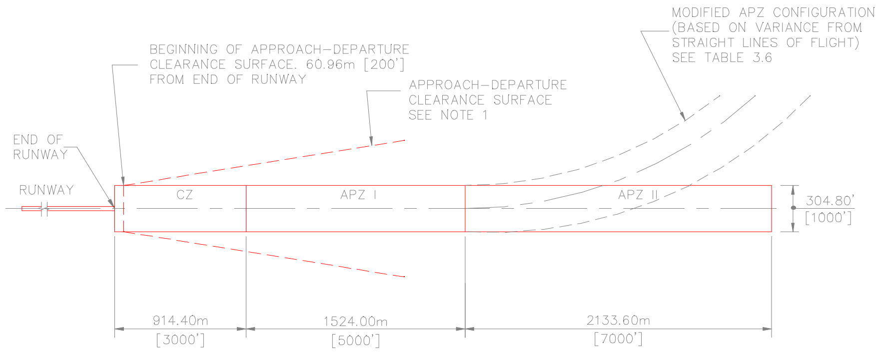
Figure 3.4. Army Clear Zone and Accident Potential Zone Guidelines.



ARMY CLASS A RUNWAY
N.T.S.

NOTES

1. THE WIDTH AND CONFIGURATION OF AN APPROACH–DEPARTURE CLEARANCE SURFACE ARE BASED ON THE CLASS OF RUNWAY, NOT THE WIDTH OF THE CLEAR ZONE.
2. FOR ADDITIONAL INFORMATION ON CLEAR ZONES, SEE TABLE 3.5.
3. FOR ADDITIONAL INFORMATION ON ACCIDENT POTENTIAL ZONES, SEE TABLE 3.6.



LEGEND

CZ CLEAR ZONE
APZ I ACCIDENT POTENTIAL ZONE I
APZ II ACCIDENT POTENTIAL ZONE II

ARMY CLASS B RUNWAY
N.T.S.

Figure 3.5. Air Force Clear Zone and Accident Potential Zone Guidelines.

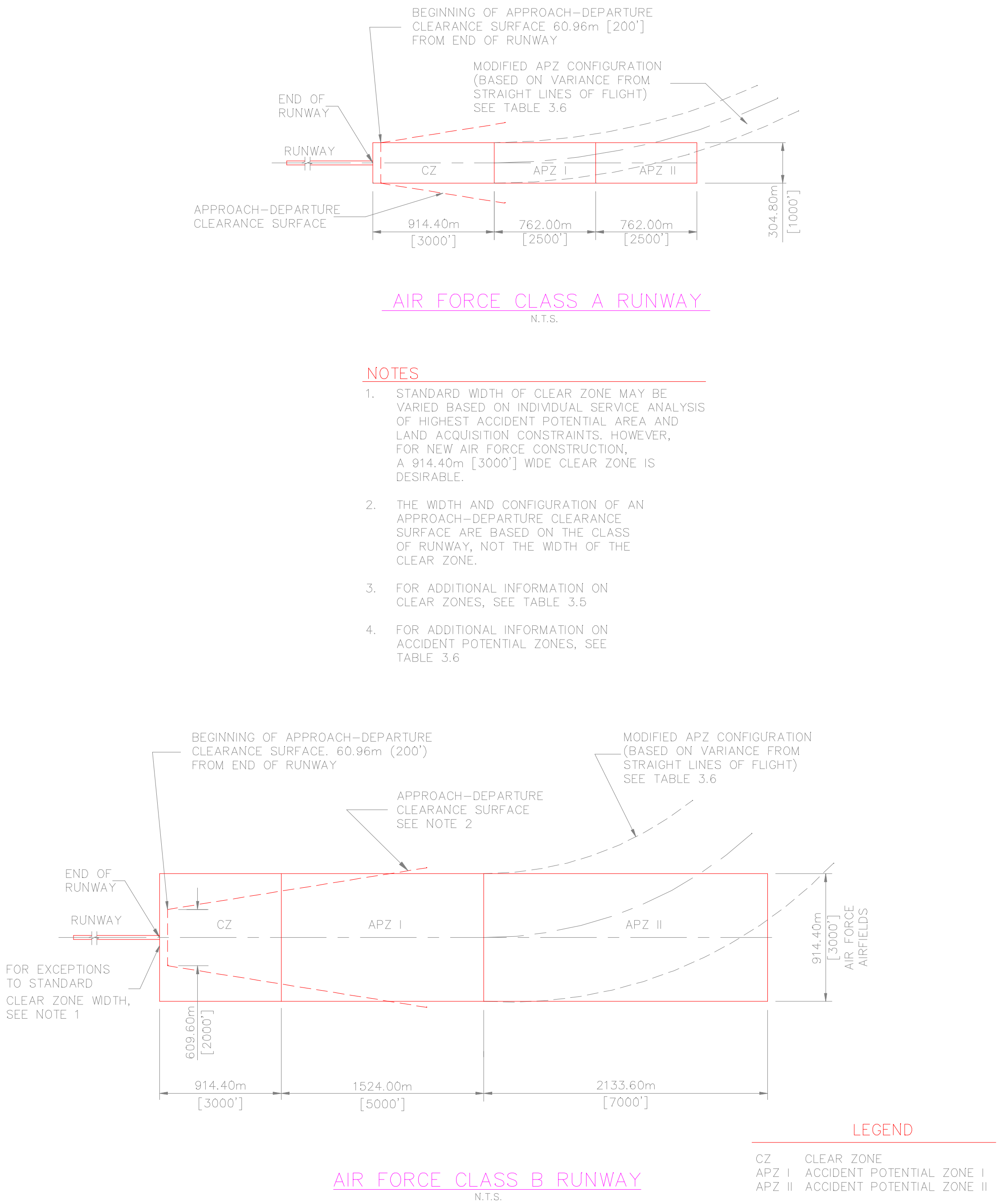
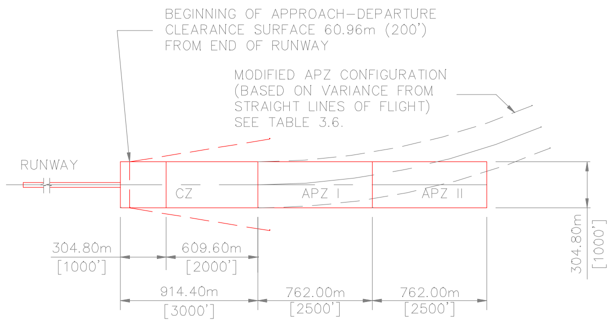


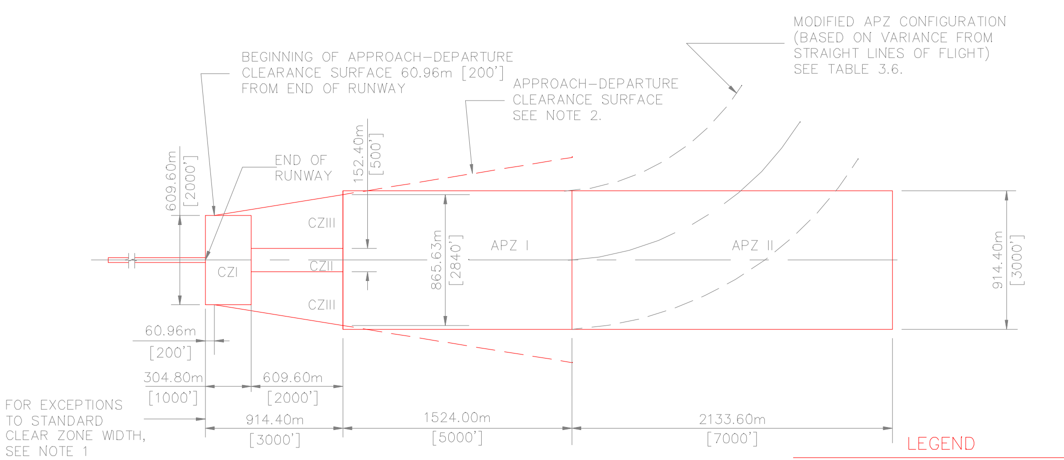
Figure 3.6. Navy and Marine Corps Clear Zone and Accident Potential Zone Guidelines.



NAVY AND MARINE CORPS CLASS A RUNWAY
N.T.S.

NOTES

1. STANDARD WIDTH OF CLEAR ZONE MAY BE VARIED BASED ON INDIVIDUAL SERVICE ANALYSIS OF HIGHEST ACCIDENT POTENTIAL AREA AND LAND ACQUISITION CONSTRAINTS. HOWEVER, FOR NEW NAVY AND MARINE CORPS CONSTRUCTION, A 914.40m [3000'] WIDE CLEAR ZONE IS DESIRABLE.
2. THE WIDTH AND CONFIGURATION OF AN APPROACH–DEPARTURE CLEARANCE SURFACE ARE BASED ON THE CLASS OF RUNWAY, NOT THE WIDTH OF THE CLEAR ZONE.
3. FOR ADDITIONAL INFORMATION ON CLEAR ZONES, SEE TABLE 3.5.
4. FOR ADDITIONAL INFORMATION ON ACCIDENT POTENTIAL ZONES, SEE TABLE 3.6.



LEGEND

CZ	CLEAR ZONE
CZ I	TYPE I CLEAR ZONE
CZ II	TYPE II CLEAR ZONE
CZ III	TYPE III CLEAR ZONE

NAVY AND MARINE CORPS CLASS B RUNWAY
N.T.S.

Figure 3.7. Class A VFR Runway Primary Surface End Details.

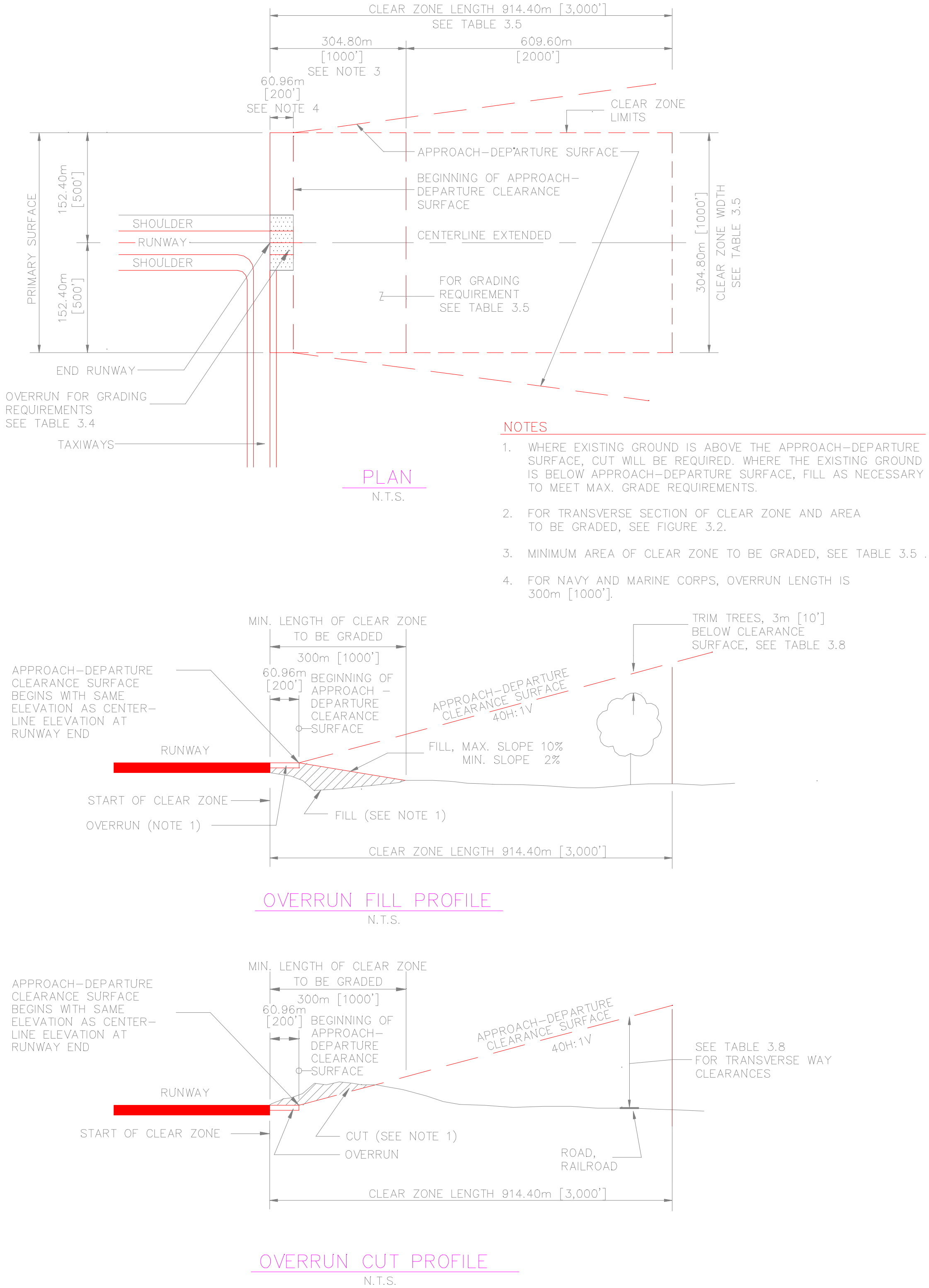
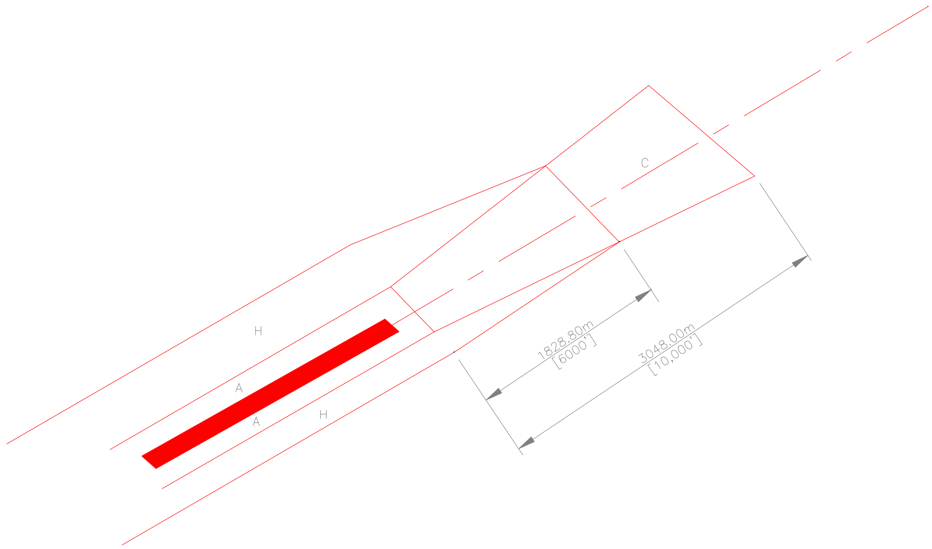


Figure 3.8. Class A VFR Runway Isometric Airspace Imaginary Surfaces.



LEGEND

A PRIMARY SURFACE
B CLEAR ZONE SURFACE (NOT SHOWN)
C APPROACH–DEPARTURE CLEARANCE SURFACE (40H:1V SLOPE RATIO)
D APPROACH–DEPARTURE CLEARANCE SURFACE (HORIZONTAL)(NOT REQUIRED)
E INNER HORIZONTAL SURFACE (NOT REQUIRED)
F CONICAL SURFACE (NOT REQUIRED)
G OUTER HORIZONTAL SURFACE (NOT REQUIRED)
H TRANSITIONAL SURFACE (7H:1V SLOPE RATIO)
I NOT USED
J ACCIDENT POTENTIAL ZONE (APZ) (NOT SHOWN)

Figure 3.9. Class A VFR Runway Plan and Profile Airspace Imaginary Surfaces.

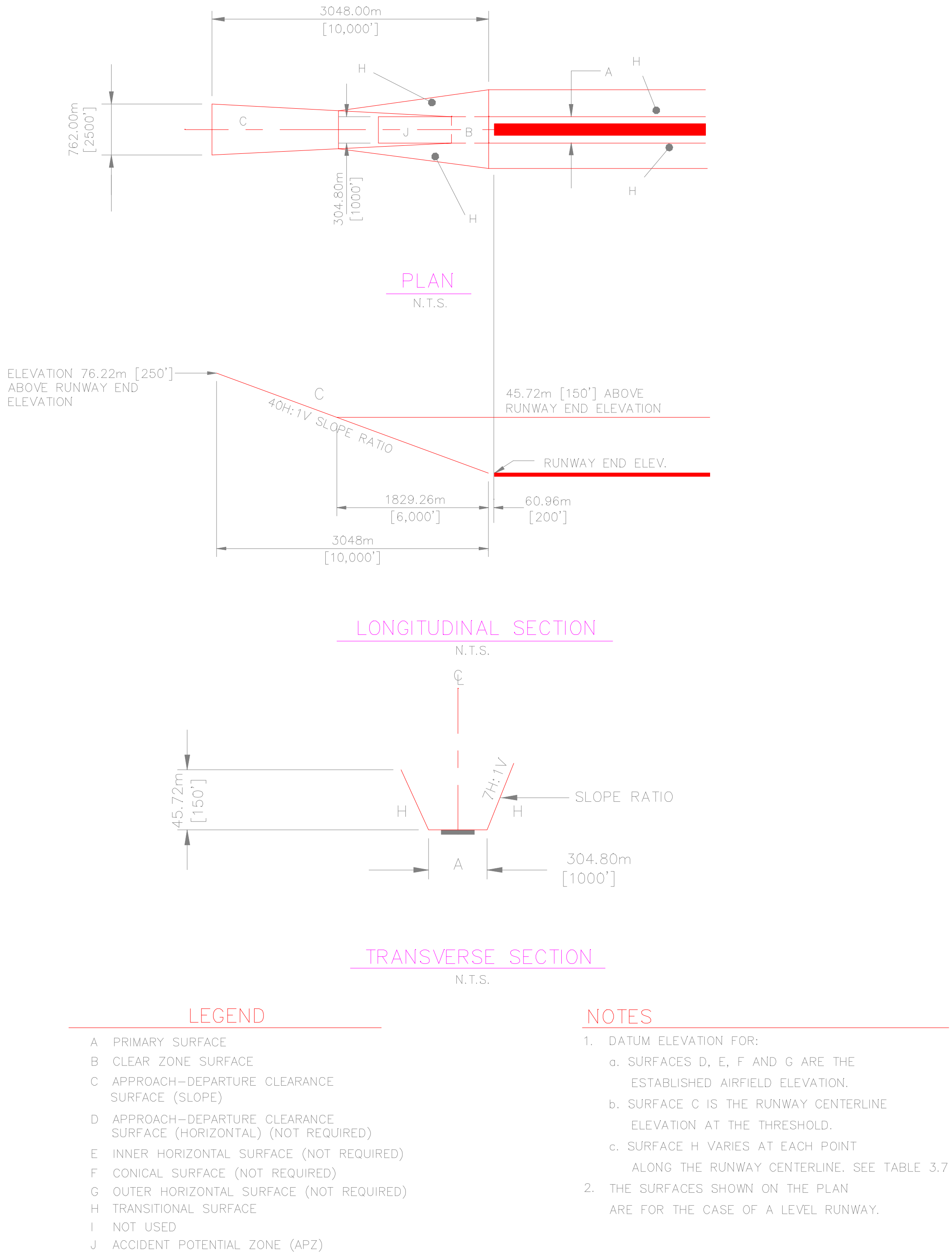


Figure 3.10. Class A IFR Runway Primary Surface End Details.

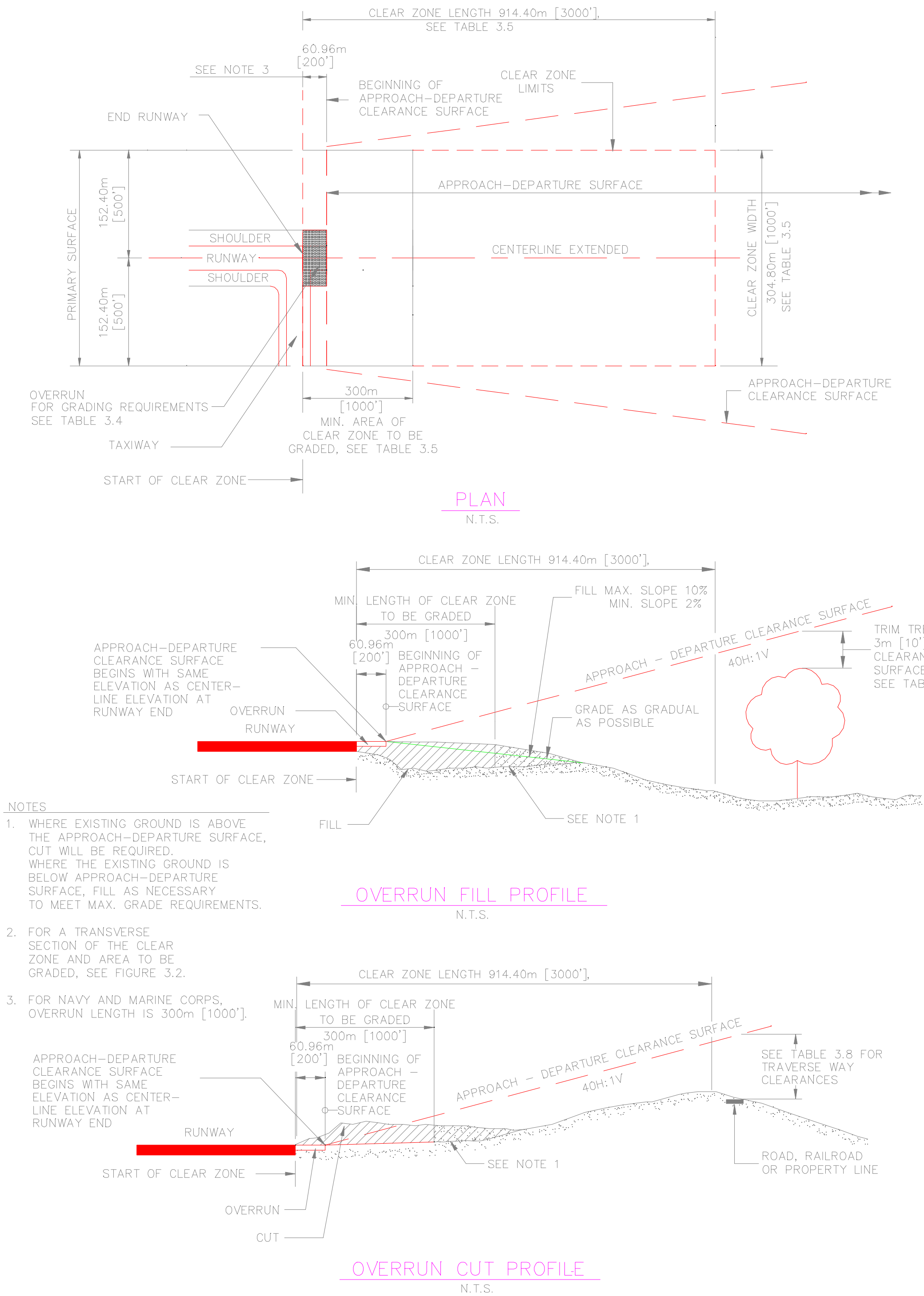
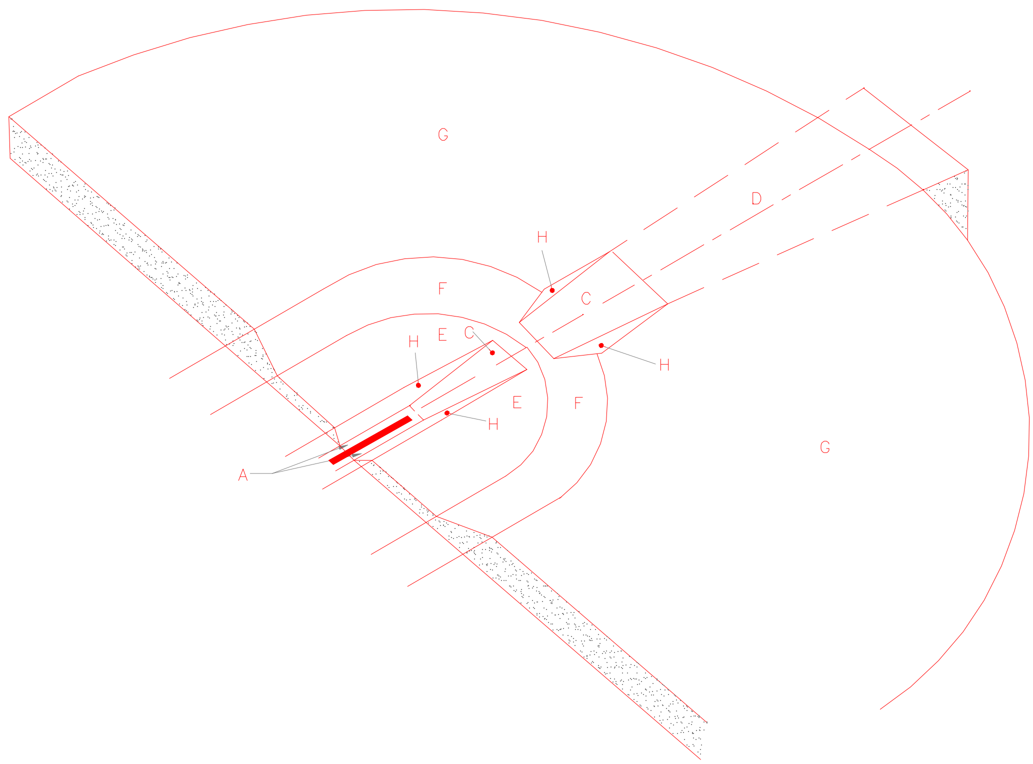


Figure 3.11. Class A IFR Runway Airspace Imaginary Surfaces.

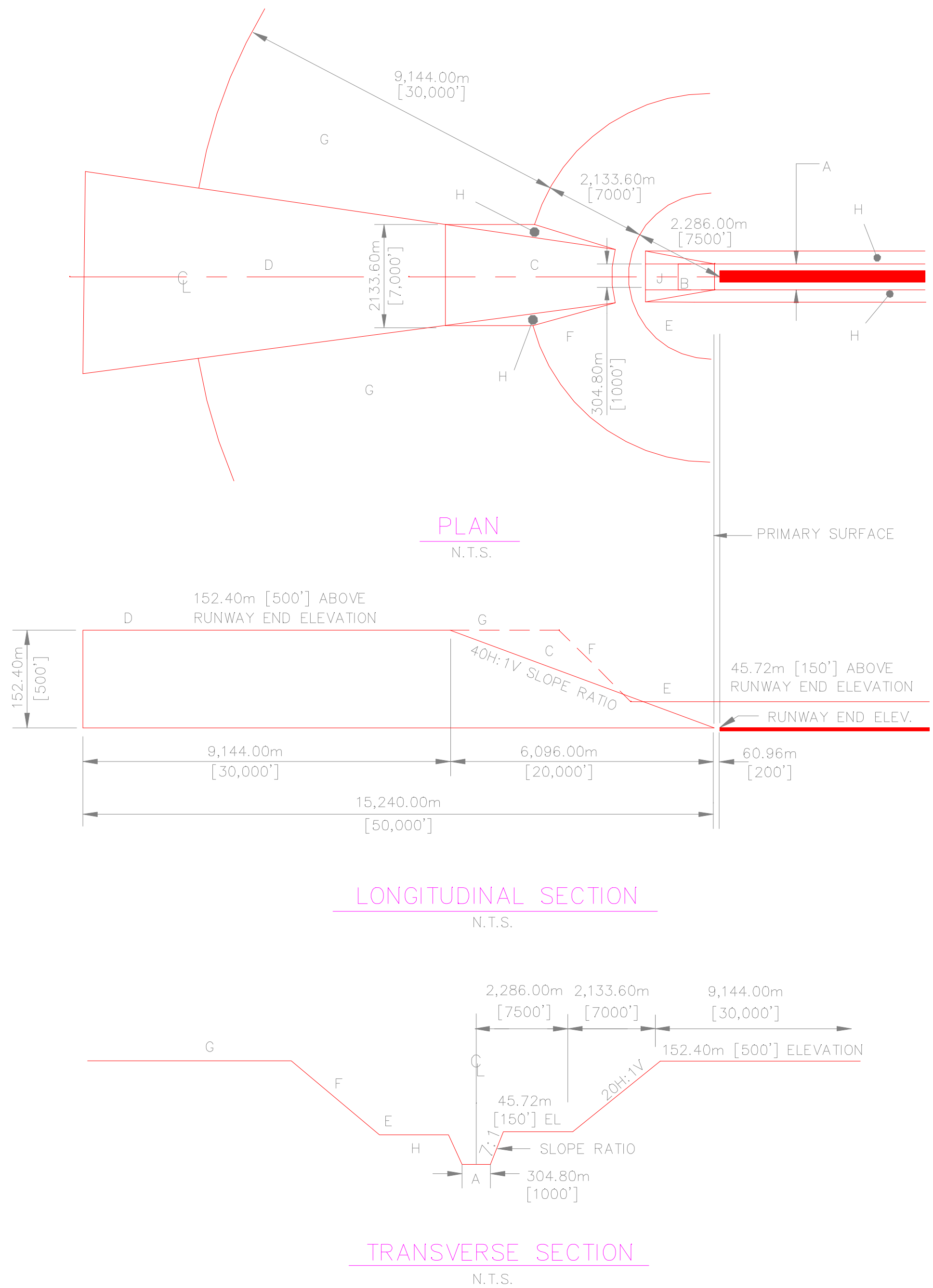


LEGEND

A PRIMARY SURFACE
B CLEAR ZONE SURFACE (NOT SHOWN)
C APPROACH–DEPARTURE CLEARANCE SURFACE (SLOPE) (40H:1V RATIO)
D APPROACH–DEPARTURE CLEARANCE SURFACE (HORIZONTAL)
E INNER HORIZONTAL SURFACE (45.72m [150'] ELEVATION)
F CONICAL SURFACE (20H:1V)
G OUTER HORIZONTAL SURFACE (152.40m [500'] ELEVATION)
H TRANSITIONAL SURFACE (7H:1V)
I NOT USED
J ACCIDENT POTENTIAL ZONE (APZ) (NOT SHOWN)

ISOMETRIC

Figure 3.12. Class A IFR Runway Plan and Profile Airspace Imaginary Surfaces.



LEGEND

- A PRIMARY SURFACE
- B CLEAR ZONE SURFACE
- C APPROACH–DEPARTURE CLEARANCE SURFACE (SLOPE)
- D APPROACH–DEPARTURE CLEARANCE SURFACE (HORIZONTAL)
- E INNER HORIZONTAL SURFACE
- F CONICAL SURFACE
- G OUTER HORIZONTAL SURFACE
- H TRANSITIONAL SURFACE
- I NOT USED
- J ACCIDENT POTENTIAL ZONE (APZ)

NOTES

1. DATUM ELEVATION FOR:
   a. SURFACES D, E, F AND G ARE THE ESTABLISHED AIRFIELD ELEVATION.
   b. SURFACE C IS THE RUNWAY CENTERLINE ELEVATION AT THE THRESHOLD.
   c. SURFACE H VARIES AT EACH POINT ALONG THE RUNWAY CENTERLINE. SEE TABLE 3.7
2. THE SURFACES SHOWN ON THE PLAN ARE FOR THE CASE OF A LEVEL RUNWAY.

Figure 3.13. Class B Army and Air Force Runway End and Clear Zone Details.

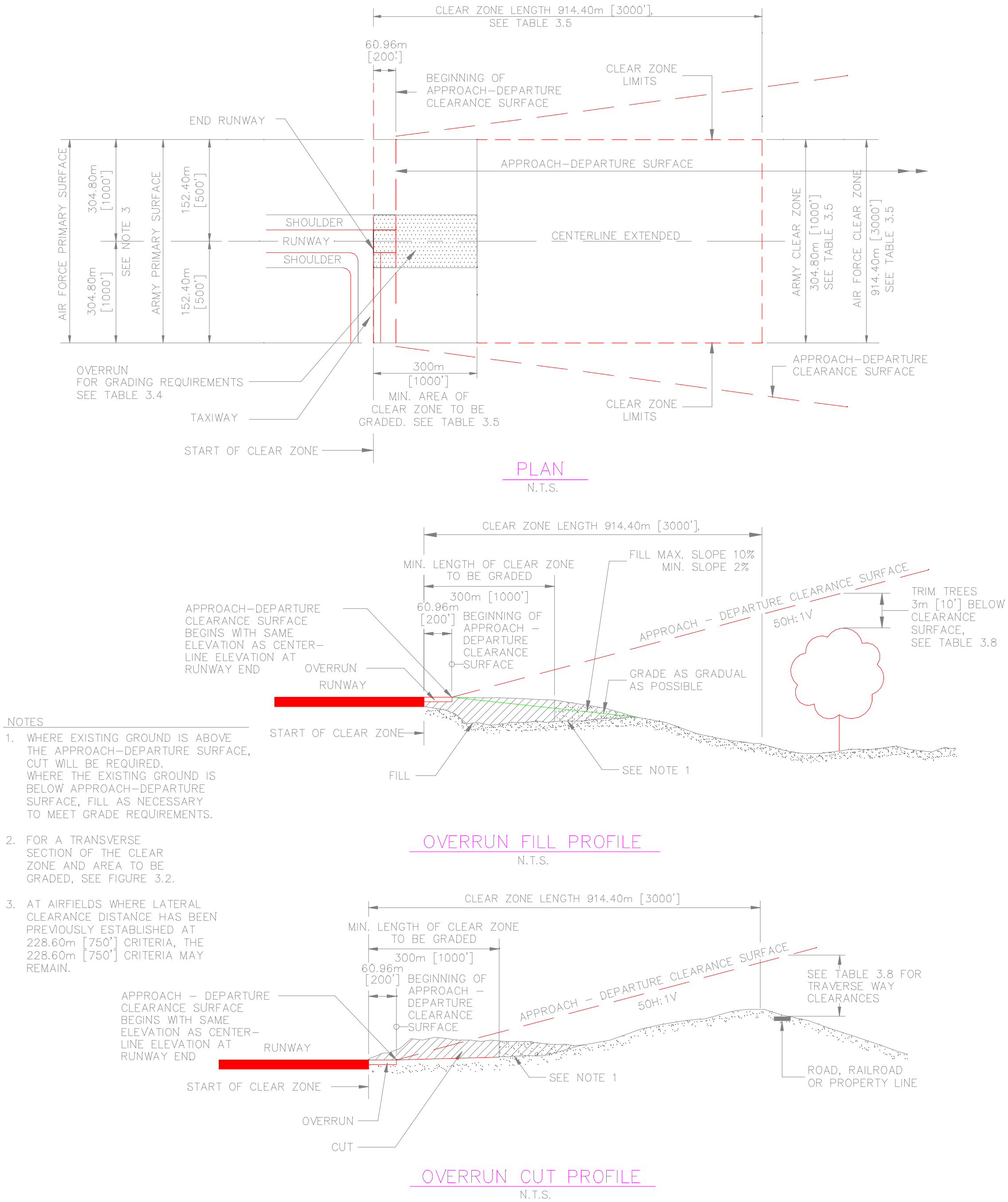


Figure 3.14. Class B Army Runway Airspace Imaginary Surfaces.

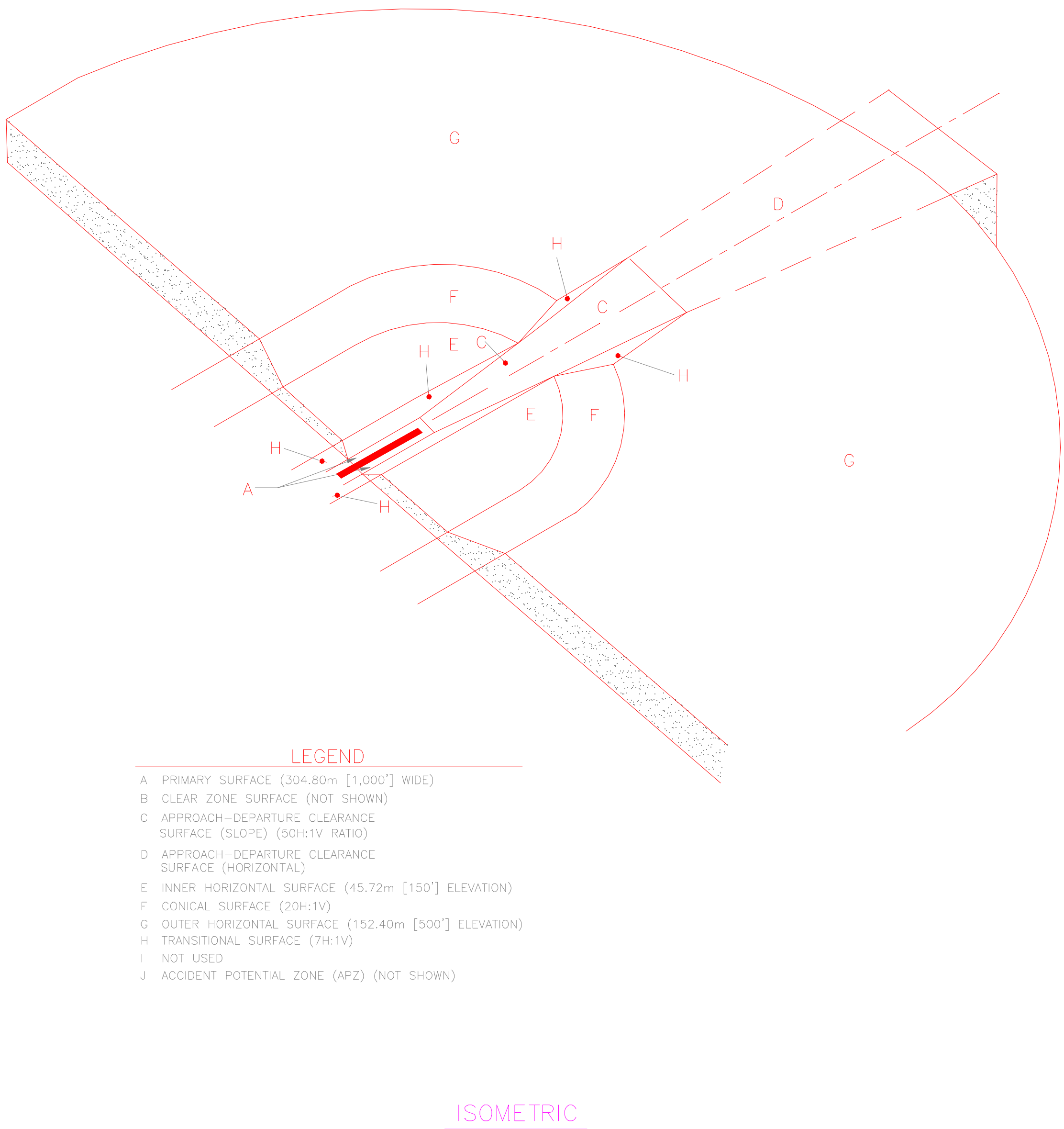
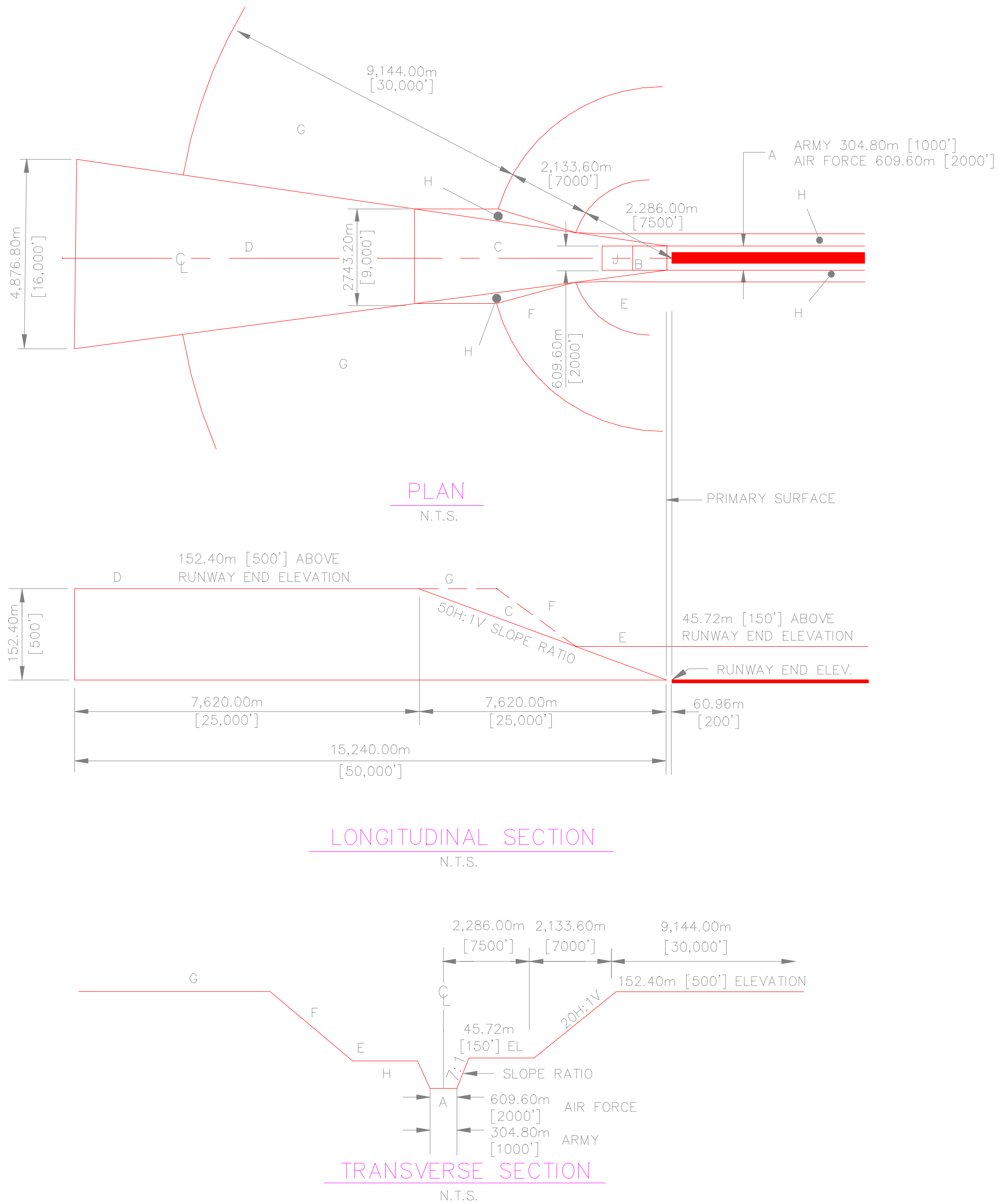


Figure 3.15. Class B Army and Air Force Runway Airspace Plan and Profile Runway Imaginary Surfaces.



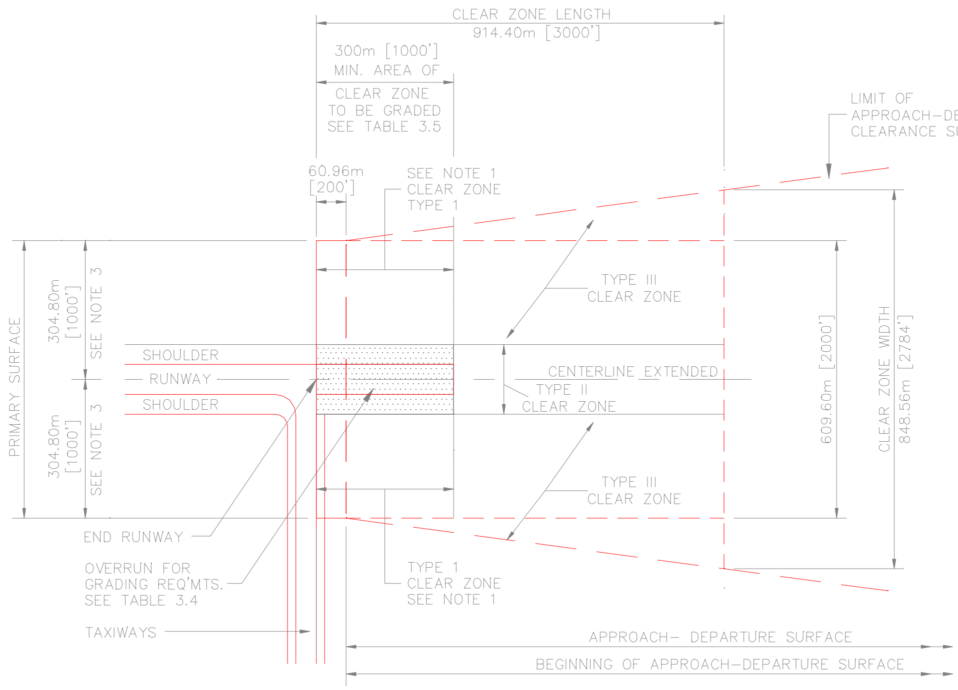
LEGEND

A PRIMARY SURFACE
B CLEAR ZONE SURFACE
C APPROACH–DEPARTURE CLEARANCE SURFACE (SLOPE)
D APPROACH–DEPARTURE CLEARANCE SURFACE (HORIZONTAL)
E INNER HORIZONTAL SURFACE
F CONICAL SURFACE
G OUTER HORIZONTAL SURFACE
H TRANSITIONAL SURFACE
I NOT USED
J ACCIDENT POTENTIAL ZONE (APZ)

NOTES

1. DATUM ELEVATION FOR:
   a. SURFACES D, E, F AND G ARE THE ESTABLISHED AIRFIELD ELEVATION.
   b. SURFACE C IS THE RUNWAY CENTERLINE ELEVATION AT THE THRESHOLD.
   c. SURFACE H VARIES AT EACH POINT ALONG THE RUNWAY CENTERLINE. SEE TABLE 3.7
2. THE SURFACES SHOWN ON THE PLAN ARE FOR THE CASE OF A LEVEL RUNWAY.

Figure 3.16. Class B Navy Runway Primary Surface End Details.



NOTES

1. WHERE EXISTING GROUND IS ABOVE THE APPROACH–DEPARTURE SURFACE, CUT WILL BE REQUIRED.

2. WHERE THE EXISTING GROUND IS BELOW APPROACH–DEPARTURE SURFACE, FILL AS NECESSARY TO MEET MAX. GRADE REQUIREMENTS.

   TYPE I CLEAR ZONE IS TO BE CLEARED, GRADED AND FREE OF ABOVE GROUND OBJECTS.

   GRADES: LONGITUDINAL MAX. 10%, MAX. GRADE CHANGE ± 2.0% PER 30m [100']
   TRANSVERSE MAX. 10%, MIN. 2%

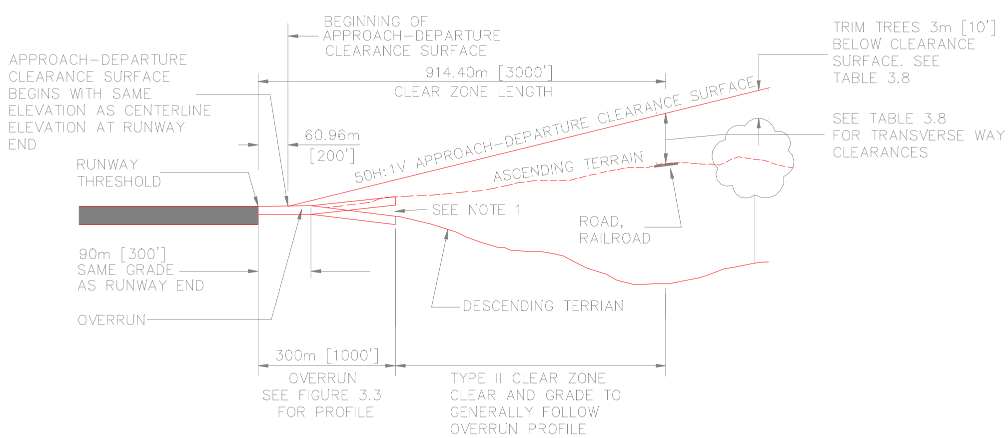
   OVERRUN: LONGITUDINAL GRADE, FIRST 90m [300'] SAME AS LAST 900m [3000'] OF RUNWAY.
   REMAINDER 1.5% MAX.
   MAX. LONG GRADE CHANGE 2% PER 30m[100']

   TYPE II CLEAR ZONE CLEAR AND GRADE TO GENERALLY FOLLOW OVERRUN PROFILE.

   TYPE III CLEAR ZONE NOT GRADED.

3. AT AIRFIELDS WHERE LATERAL CLEARANCE DISTANCE HAS BEEN PREVIOUSLY ESTABLISHED AT 228.60m [750'] CRITERIA, THE 228.60m [750'] CRITERIA MAY REMAIN.

PLAN
N.T.S.



PROFILE
N.T.S.

Figure 3.17. Class B Air Force and Navy Runway Airspace Imaginary Surfaces.

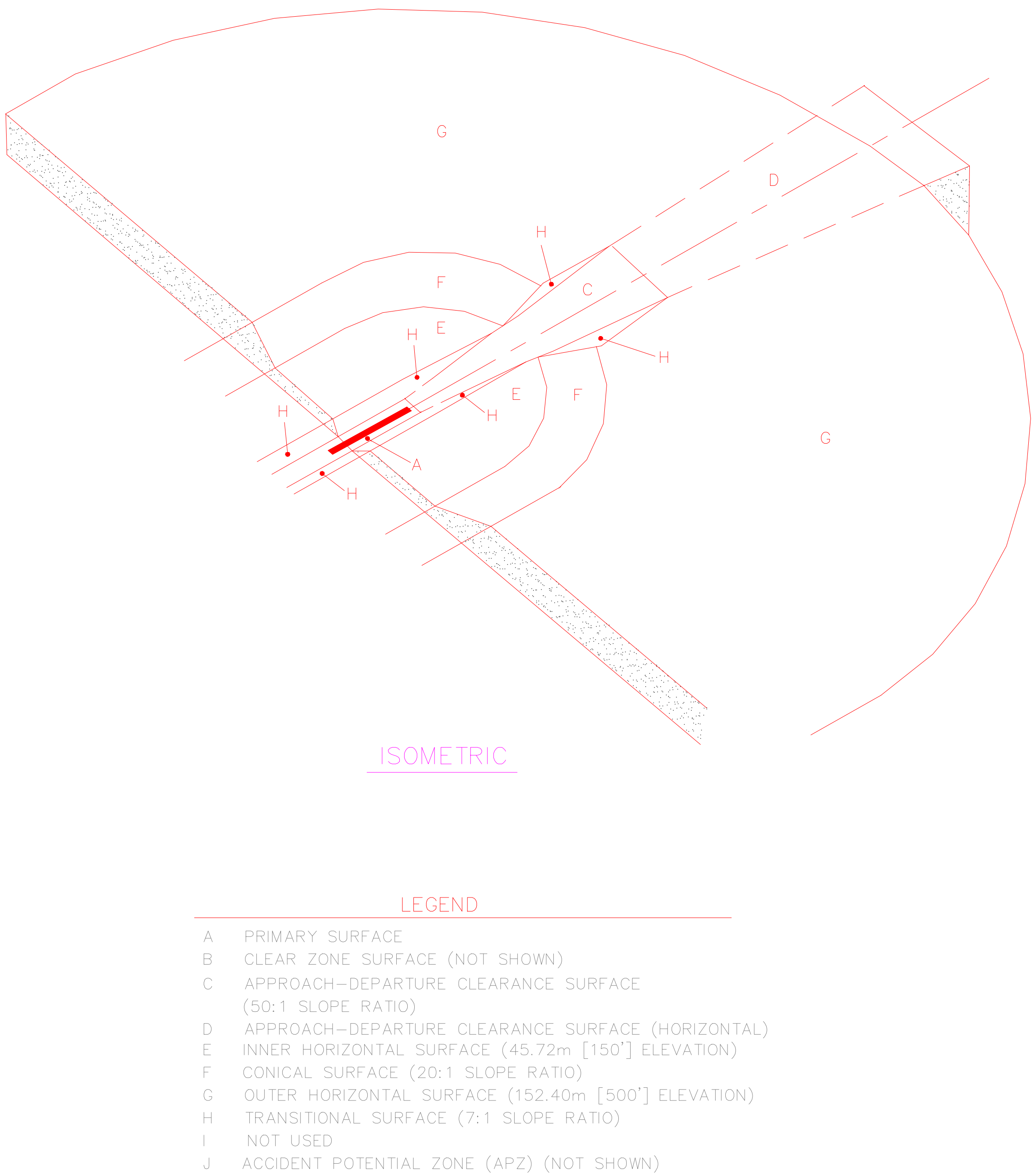
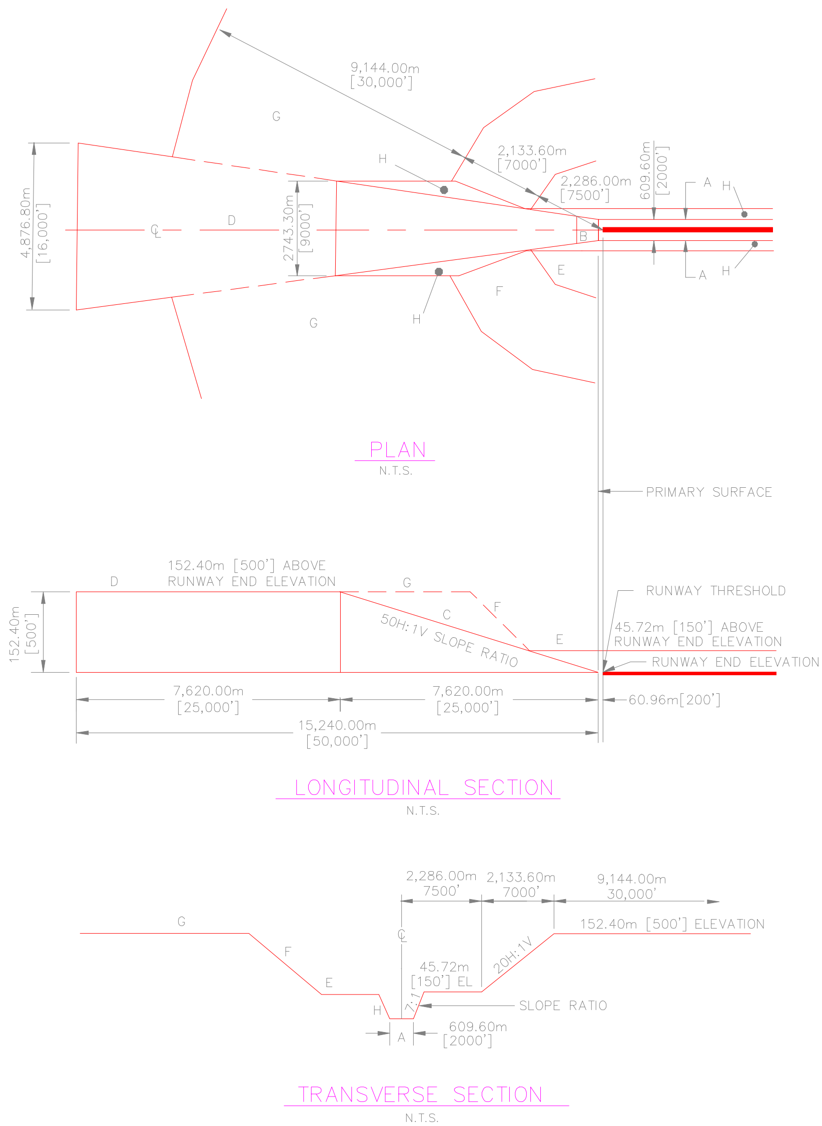


Figure 3.18. Class B Navy Runway Airspace Plan and Profile Runway Imaginary Surfaces.



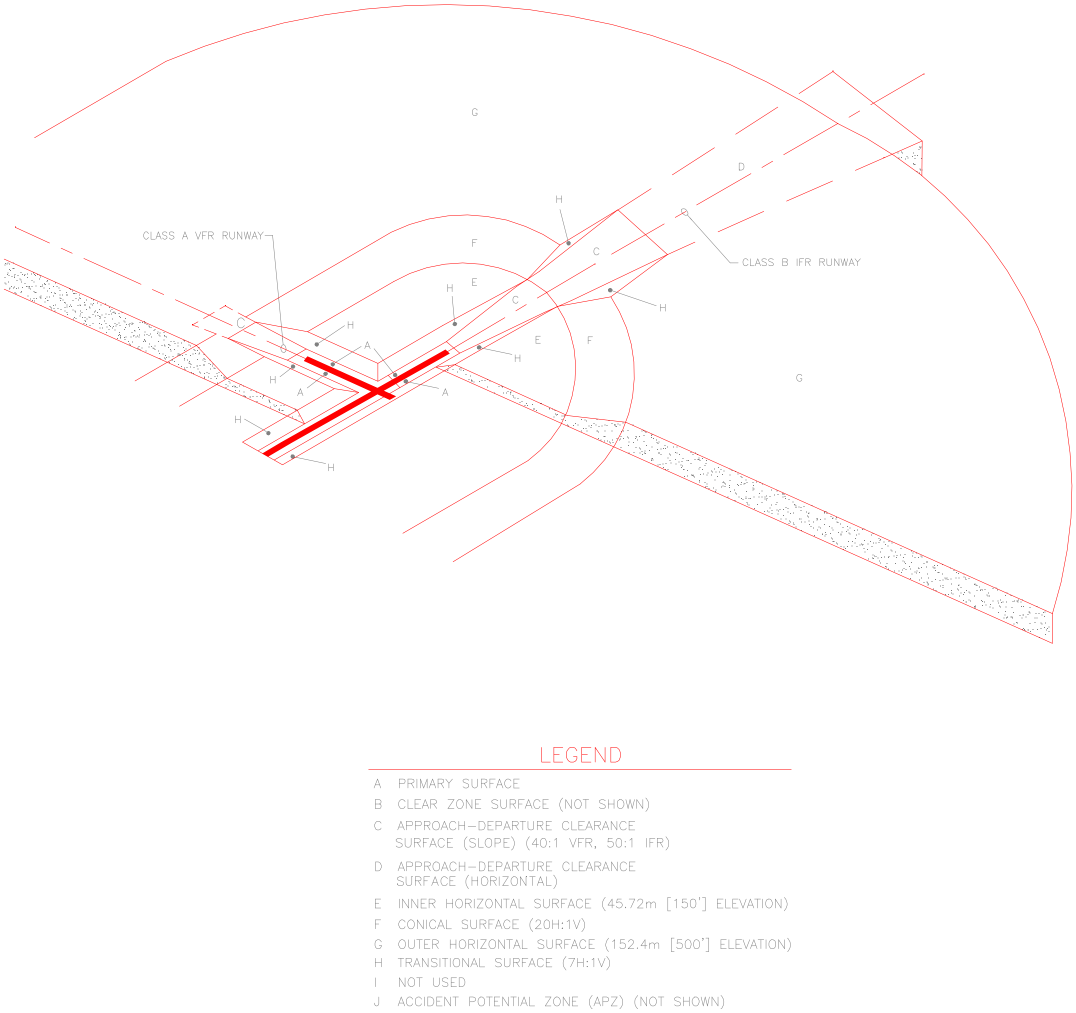
LEGEND

- A PRIMARY SURFACE
- B CLEAR ZONE SURFACE
- C APPROACH–DEPARTURE CLEARANCE SURFACE (SLOPE)
- D APPROACH–DEPARTURE CLEARANCE SURFACE (HORIZONTAL)
- E INNER HORIZONTAL SURFACE
- F CONICAL SURFACE
- G OUTER HORIZONTAL SURFACE
- H TRANSITIONAL SURFACE
- I NOT USED
- J ACCIDENT POTENTIAL ZONE (APZ) (NOT SHOWN)

NOTES

1. DATUM ELEVATION FOR:
   a. SURFACES D, E, F AND G ARE THE ESTABLISHED AIRFIELD ELEVATION.
   b. SURFACE C IS THE RUNWAY CENTERLINE ELEVATION AT THE THRESHOLD.
   c. SURFACE H VARIES AT EACH POINT ALONG THE RUNWAY CENTERLINE. SEE TABLE 3.7
2. THE SURFACES SHOWN ON THE PLAN ARE FOR THE CASE OF A LEVEL RUNWAY.

Figure 3.19. VFR and IFR Crosswind Runways Isometric Airspace Imaginary Surfaces.



3.9. Shoulders. Unprotected areas adjacent to runways and overruns are susceptible to erosion caused by jet blast. Shoulders reduce the probability of serious damage to an aircraft to a minimum in the event the aircraft runs off the runway pavement. The shoulder width, shown in Item 3 of Table 3.2, includes both paved and unpaved shoulders. Paved shoulders are required adjacent to all runways. The minimum paved shoulder width, shown in Table 3.2, allows the runway edge lights to be placed within the paved portion of the shoulder and to reduce foreign object damage (FOD) to aircraft. The unpaved shoulder should be graded to prevent water from ponding on the adjacent paved area (shoulder and runway). The drop-off next to the paved area prevents turf (which may build up over the years) from ponding water.

3.10. Runway Overruns. Runway overruns keep the probability of serious damage to an aircraft to a minimum in the event the aircraft runs off the runway during a take-off or lands short during a landing. Overruns are required for the landing and take-off area. Table 3.4 shows the dimensional requirements for overruns. Overrun profiles are shown in Figure 3.3, and an overrun layout is shown in Figures 3.7, 3.10, 3.13, and 3.16.

Table 3.3. Army Class A Runway Lengths.

Temperature	Elevation				
	Sea Level	304 m [1,000 ft]	610 m [2,000 ft]	1,524 m [5,000 ft]	1,828 m [6,000 ft]
15ºC [60ºF]	1,615 m [5,300 ft]	1,676 m [5,500 ft]	1,768 m [5,800 ft]	2,042 m [6,700 ft]	2,164 m [7,100 ft]
30ºC [85ºF]	1,707 m [5,600 ft]	1,798 m [5,900 ft]	1,890 m [6,200 ft]	2,286 m [7,500 ft]	2,438 m [8,000 ft]
40ºC [105ºF]	1,798 m [5,900 ft]	1,890 m [6,200 ft]	2,042 m [6,700 ft]	2,469 m [8,100 ft]	2,682 m [8,800 ft]

Notes:

1. Based on zero runway gradient and a clean dry runway surface for the most critical aircraft in the Army's inventory to date (RC-12N).
2. Metric units apply to new airfield construction, and where practical, to modifications to existing airfields and heliports, as discussed in Paragraph 1.4.4.

Table 3.4. Overruns.

Item No.	Item Description	Class A Runway	Class B Runway	Remarks
		Requirement		
1	Length	60 m [200 ft]	300 m [1,000 ft]	For Army and Air Force airfields
		300 m [1,000 ft]		For Navy and Marine Corps airfields At outlying fields for T-34 aircraft, the required overrun length is 150 m [500 ft].
		See Remarks.		Length of stabilized or paved area to conform to criteria of the individual DoD Service component.
2	Total Width of Overrun (Paved and Unpaved)	Sum of runway and shoulders		
3	Paved Overrun Width	Same as width of runway		Center on runway centerline extended
4	Unpaved Width of Overrun	Same width as runway shoulder		The outside edges of the overrun equal in width to the runway shoulder, is graded as overrun, but not paved.

5	Longitudinal Centerline Grade	Same as last 300 m [1,000 ft] of runway	First 90 m [300 ft] same as last 900 m [3,000 ft] of runway. Remainder: 1.5% Max	To avoid abrupt changes in grade between the first 90 m [300 feet] and remainder of overrun of a Class B runway, the maximum change of grade is 2.0 percent per 30 linear meters [100 linear feet].
6	Transverse Grade	Min 2.0% Max 3.0% 40 mm [1-½ in.] dropoff at edge of paved overrun		From centerline of overrun. Transition from the runway and runway shoulder grades to the overrun grades to be made within the first 45 meters [150 feet] of overrun.

NOTE: Geometric design criteria in this manual are based on aircraft-specific requirements and are not direct conversions from inch-pound (English) dimensions. Inch-pound units are included only to permit reference to the previous standard.

3.11. Runway Clear Zones. Runway Clear Zones are areas on the ground, located at the ends of each runway. They possess a high potential for accidents and their use is restricted to be compatible with aircraft operations. Runway Clear Zones are required for the runway. Table 3.5 shows the dimensional requirements for runway clear zones. Layout of the clear zones is shown in Figures 3.4, 3.5, 3.6, 3.7, 3.10, 3.13 and 3.17. Land use within the clear zones are shown in Attachment 4.

3.12. Accident Potential Zones (APZ). APZs are areas on the ground located beyond the clear zone of each runway. They possess a potential for accidents and their use is restricted in accordance with DoD Instruction No. 4165.57. Table 3.6 shows the dimensional requirements for runway accident potential zones. Layout of the Accident Potential Zones is shown in Figure 3.4 for the Army, Figure 3.5 for the Air Force, and Figure 3.6 for the Navy. Navy planners will use OPNAVINST 11010.36A to determine specific AICUZ requirements. Land use within the APZ I and APZ II is shown in Attachment 3.

3.13. Airspace Imaginary Surfaces:

3.13.1. Types of Airspace Imaginary Surfaces. Airspace imaginary surfaces for Army and Air Force Class B IFR Runways are similar to those at fixed-wing DoD facilities, except that the Primary Surface and Clear Zone widths are narrower for Army Runways. At fixed-wing DoD facilities, the following types of airspace imaginary surfaces may be found:

3.13.1.1. Class A VFR Runway.

3.13.1.2. Class A IFR Runway.

3.13.1.3. Class B IFR Runway for Army Facilities.

3.13.1.4. Class B IFR Runway for Air Force Facilities.

3.13.1.5. Class B IFR Runway for Navy and Marine Corps Facilities.

3.13.2. Imaginary Surfaces. The area surrounding a runway that must be kept clear of objects that might damage an aircraft is bounded by imaginary surfaces that are defined in this manual. An object, either man-made or natural, which projects above an imaginary surface is an obstruction. Imaginary surfaces for fixed-wing airfields are shown in Figures 3.6 through 3.19 and are defined in

Attachment 1. The applicable dimensions and slopes are provided in Table 3.7. These imaginary surfaces include:

3.13.2.1. Primary Surface.

3.13.2.2. Approach-Departure Surface.

3.13.2.3. Inner Horizontal Surface.

3.13.2.4. Conical Surface.

3.13.2.5. Outer Horizontal Surface.

3.13.2.6. Transitional Surface.

NOTE: Metric units apply to new airfield construction, and where practical, to modifications to existing airfields and heliports, as discussed in Paragraph 1.4.4.

Table 3.5. Clear Zones. (See note 1.)

Item No.	Item Description	Class A Runway	Class B Runway	Remarks
		Requirement		
1	Length	914.40 m [3,000 ft]	914.40 m [3,000 ft]	Measured along the extended runway centerline beginning at the runway end (see note 2).
2	Width at start of Clear Zone (adjacent to the runway)	304.80 m [1,000 ft]	304.80 m [1,000 ft]	Army airfields
			914.80 m [3,000 ft]	Air Force airfields
			609.60 m [2,000 ft]	Navy and Marine Corps (See P-80.3)
		See Remarks		Width of the Clear Zone is centered on and measured at right angles to the extended runway centerline. Exceptions to these widths are permissible based on individual service analysis of highest accident potential area for specific runway use and acquisition constraints. Refer to Figures 3.4, 3.5 and 3.6 Accident Potential Zone Guidelines.
3	Width at end of Clear Zone	304.80 m [1,000 ft]	304.80 m [1,000 ft]	Army airfields
			914.40 m [3,000 ft]	Air Force airfields

		304.80 m [1,000 ft]	848.56 m [2,784 ft]	Navy and Marine Corps The clear zone has the same dimensions as the approach-departure surface, as shown in Table 3.7. The first 60.96 m [200 ft] of the clear zone is a uniform 609.60 m [2,000 ft] in width, and which point the variable width begins.
		See Remarks		Exception to these widths are permissible based on individual service analysis of highest accident potential area for specific runway use and acquisition constraints. Refer to Figures 3.4, 3.5 and 3.6 Accident Potential Zone Guidelines. Width of the Clear Zone is centered on and measured at right angles to the extended runway centerline.
4	Longitudinal grade of area to be graded	Max 10.0%		For Army and Air Force, the area to be graded is 300 meters [1,000 ft] in length by the established width of the primary surface. Grades are exclusive of the overrun, but are to be shaped into the overrun grade. The maximum longitudinal grade change cannot exceed ± 2.0 percent per 30 meters [100 feet]. For Navy and Marine Corps, the area to be graded will be based on the type of clear zone, as shown in Figure 3.16, and discussed in NAVFAC P-80.3 and MIL-HDBK-1021. For all services, the graded area is to be cleared and grubbed of stumps and free of abrupt surface irregularities, ditches, and ponding areas. No above-ground structures (see note 3), objects, or roadways are permitted in the area to be graded, but gentle swales, subsurface drainage, covered culverts and underground structures are permissible. The transition from the graded area to the remainder of the clear zone is to be as gradual as feasible. No part of either area must penetrate the approach-departure clearance surface. For policy regarding permissible facilities, geographical features, and land use in the remainder of the clear zone, refer to guidance furnished by each individual Service, and DoD Air Installations Compatible Use Zone (AICUZ) guidelines for Clear Zones and Accident Potential Zones (See Attachment 4).
5	Transverse grade of area to be graded (in direction of surface drain-age prior to channelization)	Min 2.0% Max 10.0%		

Notes:

1. Applicable to aviation facilities installations of the Military Departments in the United States, its territories, trusts, and possessions. For military facilities overseas, other than in locations designated, apply to the maximum practical extent.
2. For the definition of runway end refer to the glossary.
3. Essential NAVAID structure exceptions are discussed in Attachment 14.
4. Airfield and heliport imaginary surfaces and safe wingtip clearance dimensions are direct conversions from inch-pound to SI units.
5. Metric units apply to new airfield construction, and where practical, to modifications to existing airfields and heliports, as discussed in Paragraph 1.4.4.

Table 3.6. Accident Potential Zones (APZ).

Item No.	Item Description	Class A Runway	Class B Runway	Remarks
		Requirement		
1	APZ I Length	762.00 [2,500 ft]	1,524.00 m [5,000 ft]	APZ I starts at the end of the Clear Zone, and is centered and measured on the extended centerline extend. Modifications will be considered if: - The runway is infrequently used. - Prevailing wind conditions are such that a large percentage (that is, over 80 percent) of the operations are in one direction. - Local accident history indicates consideration of different areas. - Most aircraft do not overfly an APZ area as defined here during normal flight operations (modifications may be made to alter these zones and adjust them to conform to the line of flight). - Other unusual conditions exist.
2	APZ I Width	304.80 m [1,000 ft]	304.80 m [1,000 ft]	Army airfields.
			914.400 m [3,000 ft]	Air Force, Navy, and Marine Corps airfields.
3	APZ II Length	762.00 m [2,500 ft]	2,133.60 m [7,000 ft]	APZ II starts at the end of the APZ I, and is centered and measured on the runway centerline extend.
4	APZ II Width	304.80 m [1,000 ft]	304.80 m [1,000 ft]	Army airfields.
			914.40 m [3,000 ft]	Air Force, Navy and Marine Corps airfields.

Notes:

1. Applicable to aviation facilities of the Military Departments in the United States, its Territories, trusts, and possessions. For military facilities overseas, other than in locations designated, follow guidance of the individual service component.

2. For guidance on land use within the APZ's, see land use compatibility guidelines in DoD Air Installations Compatible Use Zone (AICUZ) guidelines, Attachment 4.
3. Metric units apply to new airfield construction, and where practical, to modifications to existing airfields and heliports, as discussed in Paragraph 1.4.4.
4. Airfield and heliport imaginary surfaces and safe wingtip clearance dimensions are shown as a direct conversion from inch-pound to SI units.

Table 3.7. Airspace Imaginary Surfaces (Approach-Departure Clearance Surface). (See note 1)

Item No.	Item Description	Legend	Class A Runway Requirement		Class B Runway Requirement	Remarks
			VFR	IFR	VFR & IFR	
1	Primary surface width	A	304.80 m [1,000 ft]	304.80 m [1,000 ft]	304.80 m [1,000 ft]	Army airfields
					609.60 m [2,000 ft]	Air Force, Navy, and Marine Corps airfields
			See Remarks			Centered on the runway centerline. At airfields where the lateral clearance was established according to the previous 750 ft [228.60 m] from centerline criterion, the 1500 ft [228.60 m] distance may remain.
2	Primary surface length	A	Runway Length + 60.96 m [200 ft] at each end			Primary surface extends 60.96 m [200 ft] beyond each end of the runway.
3	Primary surface elevation	A	The elevation of any point on the primary surface is the same as the elevation of the nearest point on the runway centerline.			
4	Clear Zone Surface	B	See Table 3.5			
5	Start of Appr.-Dept Surface	C	60.96 m [200 ft]			Measured from the end of the runway.
6	Length of sloped portion of Appr.-Dept Surface	C	3,048.00 m [10,000 ft]	6,096.00 m [20,000 ft]	7,620.00 m [25,000 ft]	Measured horizontally.

7	Slope of Appr.-Dept Surface	C	40:1	40:1	50:1	Slope ratio is horizontal: vertical. Example: 40:1 is 40 m [ft] horizontal to 1 m [ft] vertical. For clearances over highway and railroads, see Table 3.8.
8	Width of Appr.-Dept. Surface at start of sloped portion	C	304.80 m [1,000 ft]	304.80 m [1,000 ft]	NA	
					304.80 m [1,000 ft]	Army airfields.
					609.60 m [2,000 ft]	Air Force, Navy, and Marine Corps airfields.
			See Remarks			Centered on the extended runway centerline, and is the same width as the Primary Surface. At airfields where the lateral clearance distance has been established according to the previous 750 foot [228.60 m] from centerline criterion, the 1,500 foot [457.20 m] distance at the start of the Approach-Departure Clearance Surface may remain.
9	Width of Appr.-Dept Surface at end of sloped portion	C	762.00 m [2,500 ft]	2,133.60 m [7,000 ft]	2,743.20 m [9,000 ft]	Centered on the extended runway centerline.
10	Elevation of Appr.-Dept. Surface at start of sloped portion	C	0 m [0 ft]	0 m [0 ft]	0 m [0 ft]	Same as the runway centerline elevation at the threshold.
11	Elevation of Appr.-Dept. Surface at end of sloped portion	C	76.20 m [250 ft]	152.40 m [500 ft]	152.40 m [500 ft]	Above the established airfield elevation.

12	Start of horizontal portion of Appr.-Dept Surface	D	NA	6,096.00 m [20,000 ft]	7,620.00 m [25,000 ft]	Measured from the end of the primary surface. The end of the primary surface (start of the approach-departure surface) is 60.96 m [200 ft] from the end of the runway.
13	Length of horizontal portion of Appr.-Dept Surface	D	NA	9,144.00 m [30,000 ft]	7,620.00 m [25,000 ft]	Measured horizontally along the ground.
14	Width of Appr.-Dept Surface at start of horizontal portion	D	NA	2,133.60 m [7,000 ft]	2,743.20 m [9,000 ft]	Centered along the runway centerline extended.
15	Width of Appr.-Dept Surface at end of horizontal portion	D	NA	4,876.80 m [16,000 ft]	4,876.80 m [16,000 ft]	Centered along the runway centerline extended.
16	Elevation of horizontal portion of Appr.-Dept Surface	D	NA	152.40 m [500 ft]	152.40 m [500 ft]	Above the established airfield elevation.
17	Radius of inner horizontal surface	E	NA	2,286.00 m [7,500 ft]		An imaginary surface constructed by scribing an arc with a radius of 2,286 m [7,500 ft] about the centerline at each end of each runway and inter-connecting these arcs with tangents.
18	Width of inner horizontal surface	E	NA	4,572.00 m [15,000 ft]		
19	Elevation of inner horizont-al surface	E	NA	45.72 m [150 ft]		Above the established airfield elevation.
20	Horizontal width of conical surface	F	NA	2,133.60 m [7,000 ft]		Extends horizontally outward from the outer boundary of the inner horizontal surface.

21	Slope of conical surface	F	NA	20:1		Slope ratio is horizontal:vertical. Example: 20:1 is 20 meters [feet] horizontal to 1 meter [foot] vertical
22	Elevation of conical surface at start of slope	F	NA	45.72 m [150 ft]		Above the established airfield elevation.
23	Elevation of conical surface at end of slope	F	NA	152.40 m [500 ft]		Above the established airfield elevation.
24	Distance to outer edge of conical surface	G	NA	4,419.60 m [14,500 ft]		
25	Width of outer horizontal surface	G	NA	9,144.00 m [30,000 ft]		Extending horizontally outward from the outer periphery of the conical surface.
26	Elevation of outer horizontal surface	G	NA	152.40 m [500 ft]		Above the established airfield elevation.
27	Distance to outer edge of outer horizontal surface	G	NA	13,563.60 m [44,500 ft]		An imaginary surface formed by scribing an arc with a radius of 13,563.6m about the centerline at each end of each runway, and interconnecting the arcs with tangents.
28	Start of Transitional Surface	H	152.40 m [500 ft]		152.40 m [500 ft]	At Army airfields.
			304.8 m (1,000 ft)			Air Force, Navy, and Marine Corps.
29	End of Transitional Surface	H	See Remarks			The Transitional Surface ends at the Inner Horizontal Surface, Conical Surface, Outer Horizontal Surface, or at an elevation of 45.72 m [150 ft].

30	Slope of Transitional Surfaces	H	7:1	Slope ratio is horizontal:vertical. 7:1 is 7 meters [feet] horizontal to 1 meter [foot] vertical. Vertical height of vegetation and other fixed or mobile obstacles and/or structures will not penetrate the transitional surface. Taxiing aircraft are exempt from this requirement. For Navy and Marine Corps airfields, taxiway pavements are exempt from this requirement.

Notes:

1. Approach-Departure Surfaces are based on Instrument Approach-Departure procedures. Verify Instrument Approach-Departure procedures with Army Aeronautical Service Agency, Air Force Flight Standard Agency or Navy Flight Standard Group, as appropriate, prior to using this table.
2. NA = Not Applicable
3. Airfield and heliport imaginary surfaces and safe wingtip clearance dimensions are shown as a direct conversion from inch-pound to SI units.

3.14. Airspace for Airfields with Two or More Runways. Typical airspace requirements for an airfield with multiple runways, such as a VFR and an IFR runway are shown in Figure 3.19.

3.15. Obstructions to Air Navigation. An existing object (including a mobile object) is, and a future object would be, an obstruction to air navigation if it is higher than any of the the heights or surfaces listed in Federal Aviation Regulations Part 77, *Objects Affecting Navigable Airspace*.

3.15.1. Take-Off and Landing Area. No part of the takeoff or landing area itself will be considered an obstruction.

3.15.2. Determining Obstructions. For airfields located in the United States and trust territories, an obstruction to air navigation is determined in accordance with the standards contained in Federal Aviation Regulations Part 77, *Objects Affecting Navigable Airspace*. Paragraph 77.23, "Standards for Determining Obstruction," from Part 77, has been included in Attachment 5 of this manual. For airfields located elsewhere, an obstruction is determined in accordance with either the host county’s standards, or the individual service's standards, whichever are more stringent.

3.15.3. Trees. Trees which project into the imaginary surfaces must be removed or lowered to a distance below the imaginary surface, as shown in Table 3.8.

NOTE: Metric units apply to new airfield construction, and where practical, to modifications to existing airfields and heliports, as discussed in Paragraph 1.4.4.

Table 3.8. Imaginary Surfaces Minimum Clearances over Highway, Railroad, Waterway and Trees.

Item No.	Item Description	Traverse Way/Objects	Class A and Class B Runways Dimensions
1	Minimum vertical clearance between established imaginary surfaces and traverse ways/objects (measured from the highest and nearest elevation of the traverse ways/ objects).	Interstate highway that is part of the National System of Military and Interstate Highways.	5.18 m [17 ft]
2		Other public highways not covered in item 1.	4.57 m [15 ft]
3		Private or military road.	3.05 m [10 ft] minimum, or height of highest mobile object that would usually traverse them, whichever is greater.
4		Railroad.	7.01 m [23 ft]
5		Waterway or traverse way, not previously covered.	A distance equal to the height of the highest mobile object that usually would traverse them.
6		Trees *	3 m [10 ft]

* Trees will be removed or topped the distance shown below the applicable imaginary surface.

3.16. Aircraft Arresting Systems. Aircraft arresting systems consist of engaging devices and energy absorbers. Engaging devices are net barriers, disc supported pendants (hook cables), and cable support systems which allow the pendant to be raised to the battery position or retracted below the runway surface. Energy absorbing devices are ships anchor chains, rotary friction brakes, such as the BAK-9 and BAK-12, or rotary hydraulic systems such as the BAK-13 and E-28. The systems designated "Barrier, Arresting Kit" (BAK) are numbered in the sequence of procurement of the system design. There is no connection between the Air Force designations of these systems and their function. The BAK equipment is government furnished equipment, as discussed in AFI 32-1043, *Managing Aircraft Arresting Systems*. Other designations such as E-5, E-28 and M-21 are US Navy designations. The systems in use today are as follows: MA-1A; E-5; BAK-9; BAK-12; Dual BAK-12 systems; BAK-13; BAK-14; 61QSII (BAK-15); E-28.

3.16.1. Navy and Marine Corps Requirements. This section does not apply to the Navy and Marine Corps other than to provide applicable Navy publications where additional information may be found.

3.16.2. Installation Design and Repair Considerations. Further information on the planning, installing and repairing of an arresting system or arresting system complex is found in AFI 32-1043, *Managing Aircraft Arresting Systems*. During the planning, installation and repair process, the following items will be given consideration.

3.16.2.1. Configuration and Location. The configuration and location of arresting system installations will be determined in accordance with AFI 32-1043. Design will conform with the criteria within Section 3 of the appropriate 35E8 series Technical Order and the typical installation drawings. Both may be obtained from:

SA-ALC/LDE
485 Quentin Roosevelt Road Suite 7
Kelly AFB TX 78241-5442

3.16.2.2. Runway Pavement. The 60 m [200 ft] of pavement on both the approach and departure sides of the arresting system pendant is a critical area. Protruding objects and undulating surfaces are detrimental to successful tailhook engagements and are not allowable. The maximum permissible longitudinal surface deviation in this area is plus or minus 3 mm [0.125 in] in 3.6 m [12 ft]. Changes in pavement type or an interface between rigid and flexible pavement are not permitted within this area.

3.16.2.3. Repair of Bituminous Pavements. Rigid inlays will not be used as a repair material beneath the cable in a flexible runway system. This type repair causes high hook skip potential when the flexible pavement consolidates, exposing the leading edge of the rigid pavement.

3.16.3. Joint-Use Airfields. Arresting systems installed on joint-use civil/military airfields to support military aircraft are sited in accordance with Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5220-9, *Aircraft Arresting Systems for Joint Civil/Military Airports*. It may be obtained, free of charge, from:

U.S. Department of Transportation
General Services Section
M-443.2
Washington D.C. 20590

3.16.3.1. Agreement to Install. When planning the installation of an arresting system at a joint-use facility, the installation commander must first notify the airport manager/authority of the need. If agreement is mutual, the installation commander submits the plan with sketches or drawings to the Air Force Liaison Officer within the appropriate FAA regional office. Disagreement between the responsible officials must be referred to the next higher level for resolution.

3.16.3.2. Disagreements. If a lease agreement is involved and does not allow placement of additional structures on the leased premises, the issue will be elevated to the MAJCOM for resolution.

3.16.3.3. Operating Agency. When an arresting system is installed at a joint-use civil airfield for the primary use of US military aircraft, the FAA acts for, and on behalf of, the DoD service component in operating this equipment.

3.16.3.4. Third Party Claims. Third-party claims presented for damage, injury, or death resulting from the FAA operation of the system for military aircraft or from DoD maintenance of the system is the responsibility of the DoD and must be processed under the appropriate DoD component's regulatory guidance.

3.16.3.5. DoD and FAA Agreements. Separate agreements between the DoD and the FAA are not required concerning liability for damage arising from the intentional operation of the system by FAA personnel for civil aircraft, because such claims are the responsibility of the FAA.

3.16.3.6. Operational Agreement. The MAJCOM is responsible to negotiate the operational agreement with FAA for a joint-use civil airport; however, authority may be delegated to the installation commander. The agreement will describe FAA functions and responsibilities concerning the remote control operation of arresting systems by FAA air traffic controllers.

3.16.4. Military Rights Agreements for Non-CONUS Locations. These systems are installed under the military rights agreement with the host government. If a separate agreement is specifically required for installation of a system, the installation commander coordinates with the local US diplomatic representative and negotiates the agreement with the host nation.

Chapter 4

ROTARY-WING RUNWAYS, HELIPADS, LANDING LANES, AND HOVERPOINTS

4.1. Contents. This chapter presents design standards and requirements for rotary-wing (helicopter) landing facilities: runways, helipads, helicopter landing lanes, and hoverpoints.

4.2. Landing and Take-off Layout Requirements. The landing design requirements for rotary-wing landing facilities, which include rotary-wing runways, helipads, landing lanes, slide areas (autorotation lanes), and hoverpoints, are similar to the requirements for fixed-wing runways, as discussed in Chapter 3.

4.3. Rotary-Wing Runway. The rotary-wing runway allows for a helicopter to quickly land and roll to a stop, compared to the hovering stop used during a vertical helipad approach.

4.3.1. Orientation and Designation. Consider the strength, direction, and frequency of the local winds when orienting a runway to minimize cross winds. Follow the methods for fixed-wing runways presented in Chapter 3. Runways are identified by the whole number, nearest one-tenth (1/10), of the magnetic azimuth of the runway centerline when viewed from the direction of approach.

4.3.2. Dimensions. Table 4.1 presents dimensional criteria for the layout and design of rotary-wing runways.

4.3.3. Layout. Layout for rotary-wing runways, including clear zones, are illustrated in Figure 4.1 for VFR runways and Figures 4.2 and 4.3 for IFR runways.

Table 4.1. Rotary-Wing Runways.

Item No.	Item Description	Requirement	Remarks
1	Basic Length	490 m [1,600 ft]	For Army and Air Force facilities, use basic length up to 1,220 meters [4,000 feet] in elevation above Mean Sea Level (MSL). Increase basic length to 610 meters [2,000 feet] when above 1,220 meters [4,000 feet] in elevation above MSL. For Navy and Marine Corps facilities, basic length to be corrected for elevation and temperature. Increase 10% for each 300 m [1,000 ft] in elevation above 600 m [2,000 ft] MSL and add 4.0% for each 5ºC [10ºF], above 15ºC [59ºF] for the average daily maximum temperature for the hottest month. For a special mission or proficiency training such as autorotation operations, the length may be increased up to 300 meters [1,000 feet]; in which case, make no additive corrections.
		137.2 m (450 ft)	For facilities constructed prior to publication of this manual.
2	Width	23 m [75 ft]	Increase width to 30 meters [100 feet] on runways which regularly accommodate H-53.

3	Longitudinal Grade	Max. 1.0%	Maximum longitudinal grade change is 0.167% per 30 linear meters [100 linear feet] of runway. Exceptions: 0.4% per 30 linear meters (100 linear feet) for edge of runways at runway intersections.
4	Transverse Grade	Min. 1.0% Max. 1.5%	From centerline of runway. Runway may be crowned or uncrowned.
5	Paved Shoulders		See Table 4.4.
6	Runway Lateral Clearance Zone (corresponds to half the width of primary surface area)	45.72 m [150 ft]	VFR operations.
		114.30 m [375 ft]	IFR operations.
		See Remarks	Measured perpendicularly from centerline of runway. This area is to be clear of fixed and mobile obstacles. In addition to the lateral clearance criterion, the vertical height restriction on structures and parked aircraft as a result of the transitional slope must be taken into account. (1) Fixed obstacles include manmade or natural features constituting possible hazards to moving aircraft. Navigational aids and meteorological equipment are possible exceptions. For Army and Air Force, siting exceptions for navigational aids and meteorological facilities are found in Attachment 14 of this manual. For Navy and Marine Corps, siting exceptions for navigational aids and meteorological facilities are found in NAVFAC P-80.3. (2) Mobile obstacles include parked aircraft, parked and moving vehicles, railroad cars and similar equipment. (3) Taxiing aircraft are exempt from this restriction. However, parallel taxiways (exclusive of shoulder width) must be located in excess of the lateral clearance distance.
7	Grades Within the Primary Surface Area in Any Direction	Max. 5.0%	Exclusive of pavement and shoulders. For Air Force installations, a minimum of 2.0 percent before channelization.
8	Overrun		See Table 4.5.

9	Distance from the Centerline of a Fixed-Wing Runway to the Centerline of a Parallel Rotary-Wing Runway, Helipad, or Landing Lane	Min. 213.36 m [700 ft]	Simultaneous VFR operations for Class A Runway and Army Class B Runway.
		Min. 304.80 m [1,000 ft]	Simultaneous VFR operations for Class B Runway for Air Force, Navy and Marine Corps.
		Min. 213.36 m [700 ft]	Non-simultaneous operations. Distance may be reduced to 60.96 m [200 ft]; however, waiver must be based on wake-turbulence and jet blast. In locating the helipad, consideration must be given to hold position marking. Rotary-wing aircraft must be located on the apron side of the hold position markings (away from the runway) during runway operations.
		Min. 762.00 m [2,500 ft]	Instrument Flight Rules (IFR) using simultaneous operations (Depart-Depart) (Depart-Approach).
		Min. 1,310.64 m [4,300 ft]	Instrument flight rules (IFR) using simultaneous approaches.
10	Distance Between Centerlines of: (a) Parallel Rotary-Wing Runways, Helipads, or Any Combination Thereof. (b) Landing Lane and Parallel Rotary-Wing Runway or Helipad.	Min. 213.36 m [700 ft]	Visual flight rules (VFR) without intervening parallel taxiway between centerlines.
		Min. 762.00 m [2,500 ft]	Instrument Flight Rules (IFR) using simultaneous operations (Depart-Depart) (Depart-Approach).
		Min. 1,310.64 m [4,300 ft]	Instrument flight rules (IFR) using simultaneous approaches.

NOTES:

1. Metric units apply to new airfield construction and where practical modification to existing airfields and heliports, as discussed in paragraph 1.4.4.
2. The criteria in this manual are based on aircraft specific requirements and are not direct conversions from inch-pound (English) dimensions. Inch-pound units are included only as a reference to the previous standard.
3. Airfield and heliport imaginary surfaces and safe wingtip clearance dimensions are shown as a direct conversion from inch-pound to SI units.

Figure 4.1. Helicopter VFR Runway.

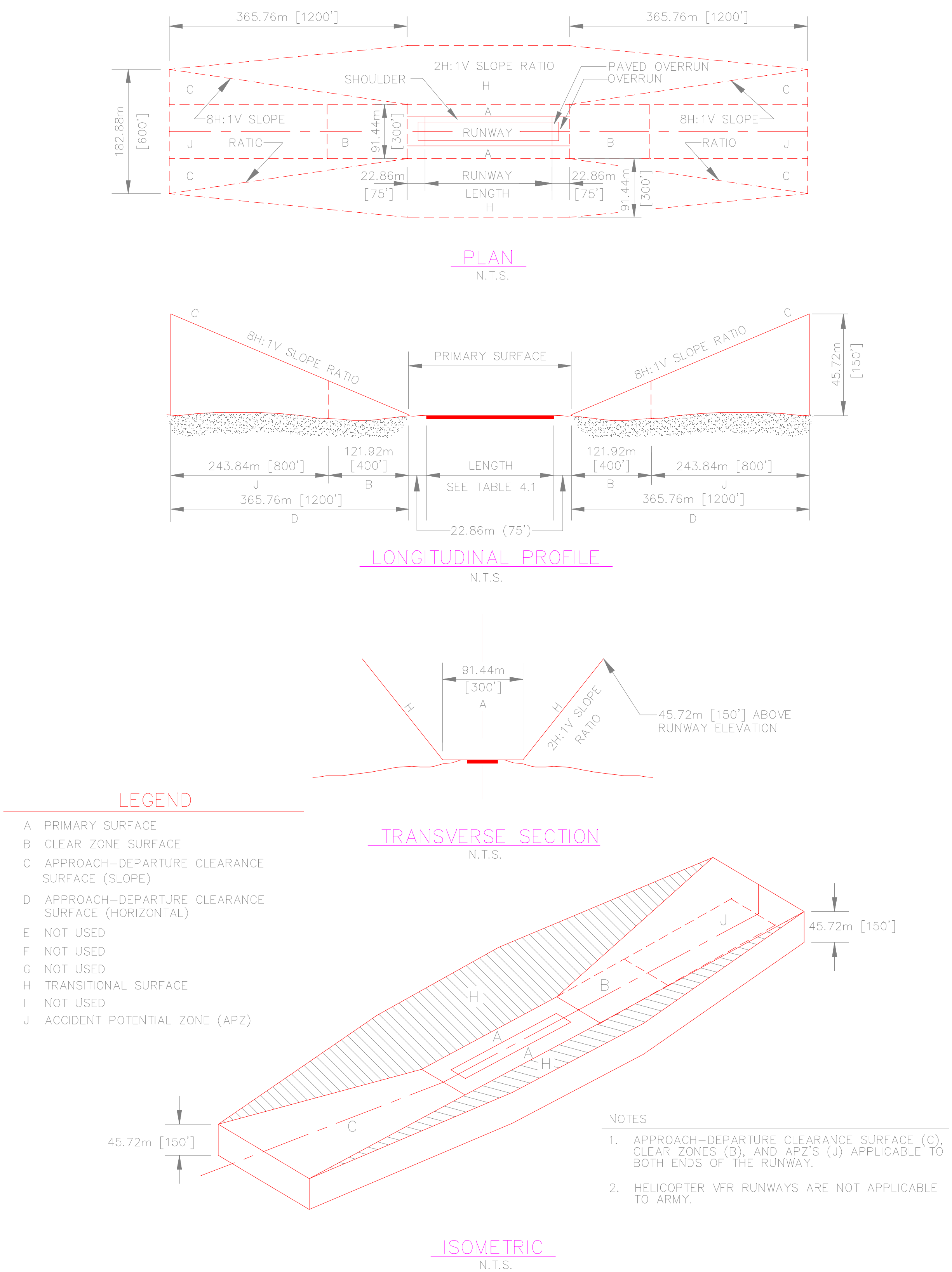


Figure 4.2. Helicopter IFR Runway.

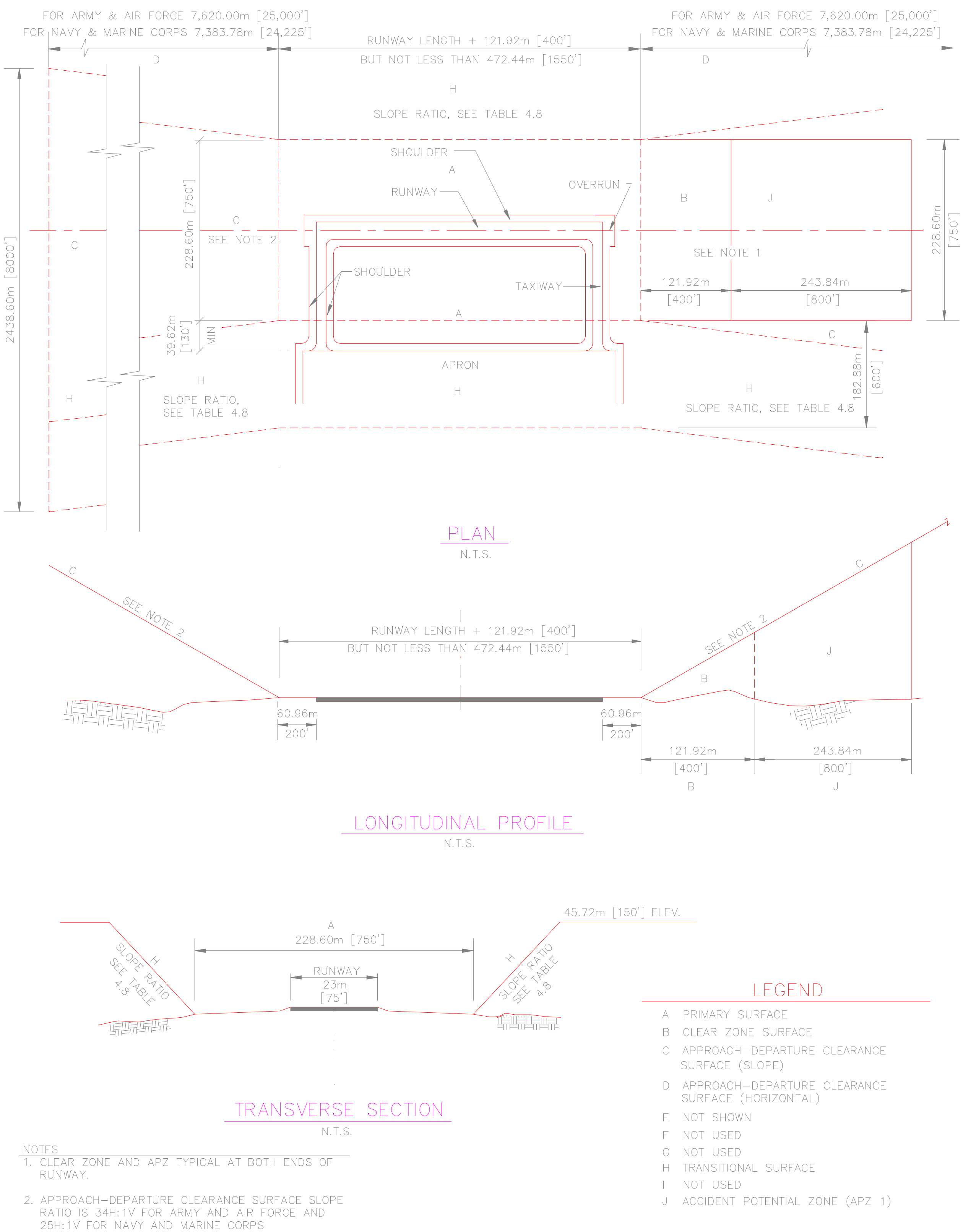
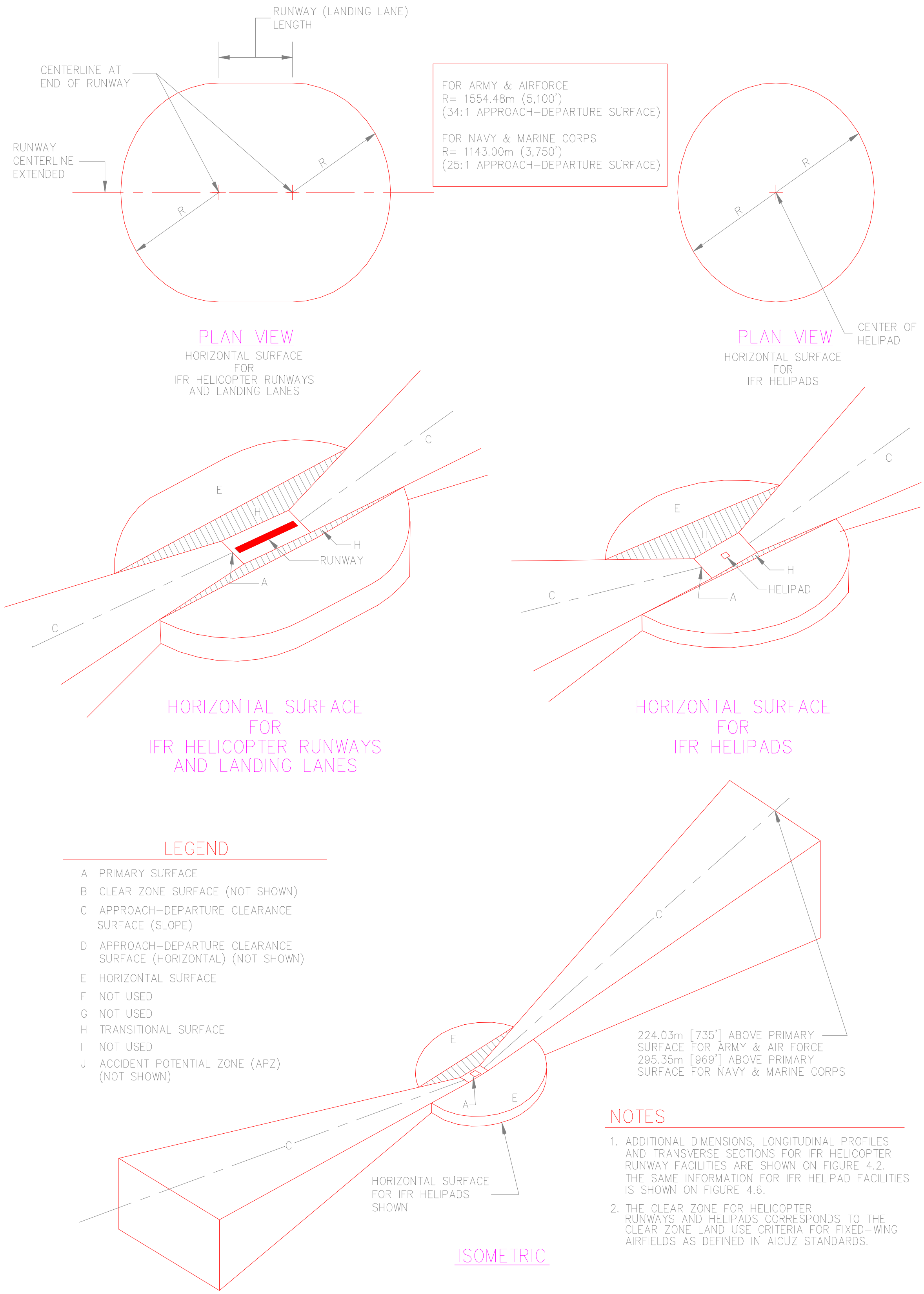


Figure 4.3. IFR Airspace Imaginary Surfaces — IFR Helicopter Runway and Helipad.



4.4. Helipads. Helipads allow for a helicopter hovering, landing, and take-off. Except at facilities where helicopter runways are provided, helipads are the landing and take-off locations for helicopters. The Army and Air Force provide for three types of helipads: Standard Visual Flight Rules (VFR) Helipad; Limited Use Helipad; and Instrument Flight Rules (IFR) Helipad. The Navy and Marine Corps only provide one type of helipad: Standard Size Helipad. The type of helipad depends on the following operational requirements:

4.4.1. Standard VFR Helipad. VFR design standards are used when no requirement exists or will exist in the future for an IFR helipad. Criteria for this type of helipad permit the accommodation of most helipad lighting systems.

4.4.2. Limited Use Helipad. This is a VFR facility used at sites where only occasional operations are conducted. These sites may be, but are not limited to, hospitals, headquarter areas, missile sites, and established airfields or heliports where the Limited-Use Helipad may be used to preclude mixing helicopters and fixed-wing traffic. Limited Use Helipads may also be used to separate light helicopter traffic (5,670 kg [12,500 lbs] or less) from medium and heavy helicopter traffic.

4.4.3. IFR Helipad. IFR design standards are used when an instrument approach capability is essential to the mission and no other instrument landing facilities, either fixed-wing or rotary-wing, are located within an acceptable commuting distance to the site.

4.4.4. Helipad Location. A helipad location should be selected with regard to mission requirements, overall facility development, approach-departure surfaces, and local wind conditions.

4.4.4.1. Near Runways. When a helipad is to be located near fixed- and rotary-wing runways, its location should be based on type of operations, in accordance with criteria in Table 4.1.

4.4.4.2. Above Ground Helipads. Construction of helipads on buildings or on any type of elevated structure above ground is not authorized for Air Force and Army. For these agencies, helipads will be constructed as a slab on grade. For Navy and Marine Corps facilities, contact the agency aviation office with safety waiver approval if deviation is required.

4.4.4.3. Parking Pads. At individual helipad sites where it is necessary to have one or more helicopters on standby, an area adjacent to the helipad, but clear of the landing approach and transitional surfaces, should be designated for standby parking. This area will be designed as a parking apron in conformance with the criteria presented in Chapter 6.

4.4.5. Dimensional Criteria. Table 4.2 presents dimensional criteria for the layout and design of helipads.

Table 4.2. Rotary-Wing Helipads and Hoverpoints.

Item No.	Item Description	Requirement	Remarks
1	Size	15 m x 15 m [50 ft x50 ft] min.	Air Force and Army VFR limited use helipads.
		30 m x 30 m [100 ft x[100 ft] min.	Standard VFR and IFR helipad.
		9 m (30 ft) diameter	Hoverpoints.

2	Grade	Min. 1.0% Max. 1.5%	Grade helipad in one direction. Hoverpoints should be domed to a 150 mm (6 inch) height at the center.
3	Paved Shoulders		See Table 4.4.
4	Size of Primary Surface (center primary surface on helipad)	45.72 m x 45.72 [150 ft x 150 ft] min.	Hoverpoints.
			Air Force and Army limited use VFR helipad.
			Navy and Marine Corps Standard VFR helipad.
		91.44 m x 91.44 m [300 ft x 300 ft]	Air Force and Army standard VFR helipad.
		472.44 m x 228.60 m [1,550 ft x 750 ft]	Standard IFR. Long dimension in direction of helicopter approach.
		228.60 m x 228.60 m [750 ft x 750 ft]	Army and Air Force IFR same direction ingress/egress.
5	Grades Within the Primary Surface Area in Any Direction	Min. of 2.0% prior to channelization.* Max. 5.0%	Exclusive of pavement and shoulders. For IFR helipads, the grading requirements apply to a 91.44 m × 91.44 m (300 ft × 300 ft) area centered on the helipad. The balance of the area is to be clear of obstructions and rough graded to the extent necessary to reduce damage to aircraft in event of an emergency landing. For VFR helipads, the grade requirements apply to the entire primary surface.
6	Length of Clear Zone**	121.92 m [400 ft]	Hoverpoints, VFR, and standard IFR helipads. Begins at the end of the primary surface.
		251.46 m [825 ft]	Army and Air Force IFR same direction ingress/egress.
7	Width of Clear Zone**		Corresponds to the width of the primary surface. Center Clear Zone width on extended center of the pad.
		45.72 m [150 ft]	Air Force and Army VFR limited use helipads and hoverpoints. Navy and Marine Corps Standard VFR.
		91.44 m [300 ft]	Air Force and Army standard VFR helipad and VFR helipad same direction ingress/egress.
		228.60 m [750 ft]	Standard IFR helipad.
8	Grades of Clear Zone** any direction	5.0% max	Area to be free of obstructions. Rough grade and turf when required.

9	APZ I Length***	243.84 m [800 ft]	Hoverpoints, VFR, and standard IFR.
		121.92 m [400 ft]	Army and Air Force IFR same direction ingress/egress.
10	APZ I Width***	45.72 m [150 ft]	Army and Air Force VFR limited use and hoverpoints. Navy and Marine Corps standard VFR.
		91.44 m [300 ft]	Army and Air Force standard VFR.
		228.60 m [750 ft]	Standard IFR.
11	Distance Between Centerline of Helipad and Fixed or Rotary Wing Runways		See Table 4.1.

* Bed of channel may be flat.

** The clear zone area for helipads corresponds to the clear zone land use criteria for fixed-wing airfields as defined in DoD AICUZ standards. The remainder of the approach-departure zone corresponds to APZ I land use criteria similarly defined. APZ II criteria is not applicable for rotary-wing aircraft.

*** There are no grading requirements for APZ I.

NOTES:

1. Metric units apply to new airfield construction and where practical modification to existing airfields and heliports, as discussed in paragraph 1.4.4.
2. The criteria in this manual are based on aircraft specific requirements and are not direct conversions from inch-pound (English) dimensions. Inch-pound units are included only as a reference to the previous standard.
3. Airfield and heliport imaginary surfaces and safe wingtip clearance dimensions are shown as a direct conversion from inch-pound to SI units.

4.4.6. Layout Criteria. Layouts for standard, limited use, and IFR helipads, including clear zones, are illustrated in Figures 4.4 through 4.6.

4.5. Same Direction Ingress/Egress. Helipads with same direction ingress/egress allow a helicopter pad to be located in a confined area where approach-departures are made from only one direction. The approach may be either VFR or IFR.

4.5.1. Dimensions Criteria. Table 4.2 presents dimensional criteria for the VFR and IFR one direction ingress/egress helipads.

4.5.2. Layout Criteria. Layout for VFR and IFR same direction ingress/egress are illustrated in Figures 4.7 and 4.8.

4.6. Hoverpoints:

4.6.1. General.. A hoverpoint is a prepared and marked surface used as a reference or control point for air traffic control purposes by arriving or departing helicopters.

4.6.2. Hoverpoint Location. A hoverpoint is located in a non-traffic area.

4.6.3. Dimensions. Table 4.2 presents dimensional criteria for the layout and design of hoverpoints.

4.6.4. Layout. Hoverpoint design standards are illustrated in Figure 4.9.

4.7 Rotary-Wing Landing Lanes. Except when used as an autorotation lane, these lanes permit efficient simultaneous use by a number of helicopters in a designated traffic pattern.

Figure 4.4. Standard VFR Helipad for Army and Air Force.

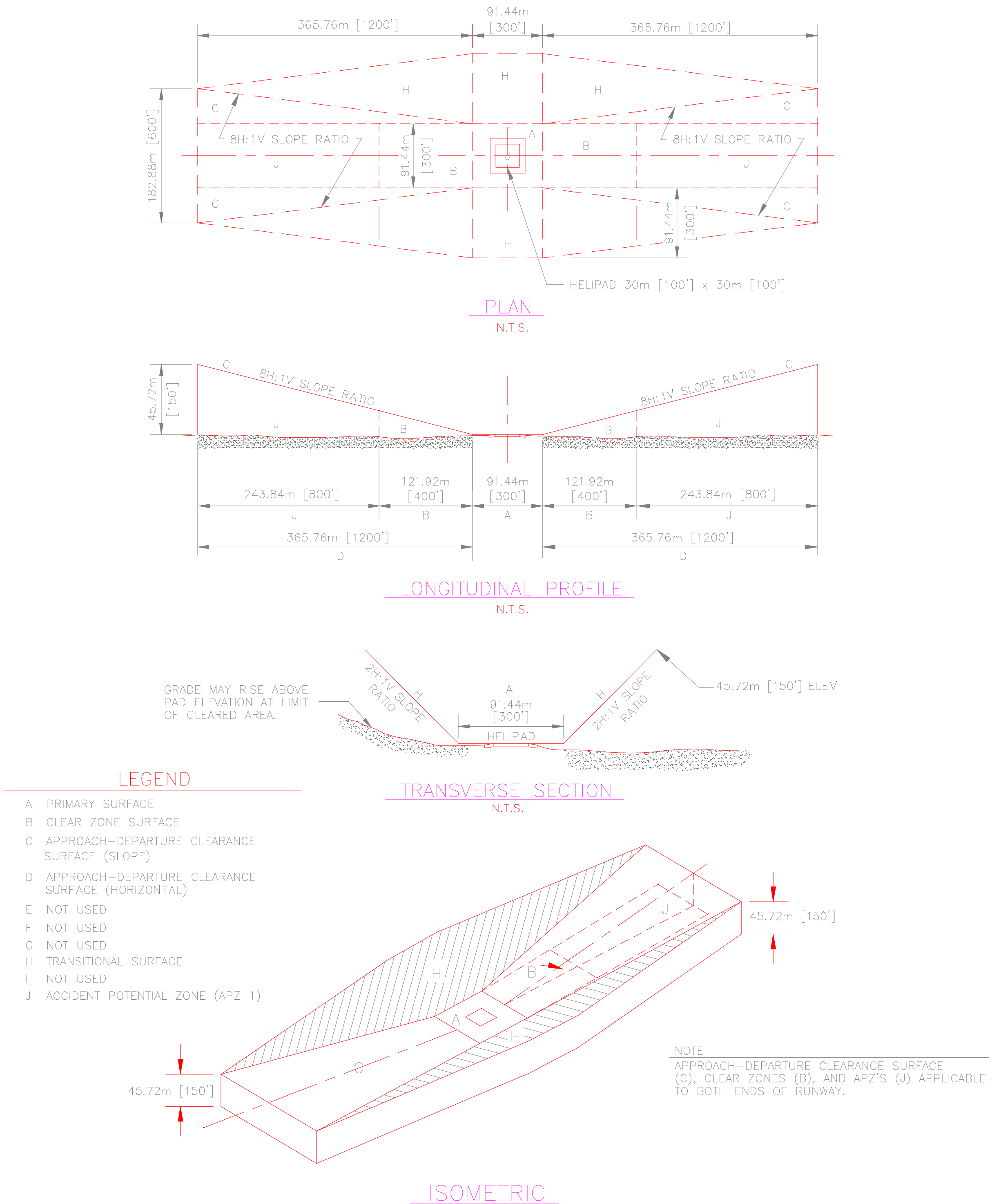


Figure 4.5. Standard VFR Helipad for Navy and Marine Corps and Limited Use VFR Helipad for Army and Air Force.

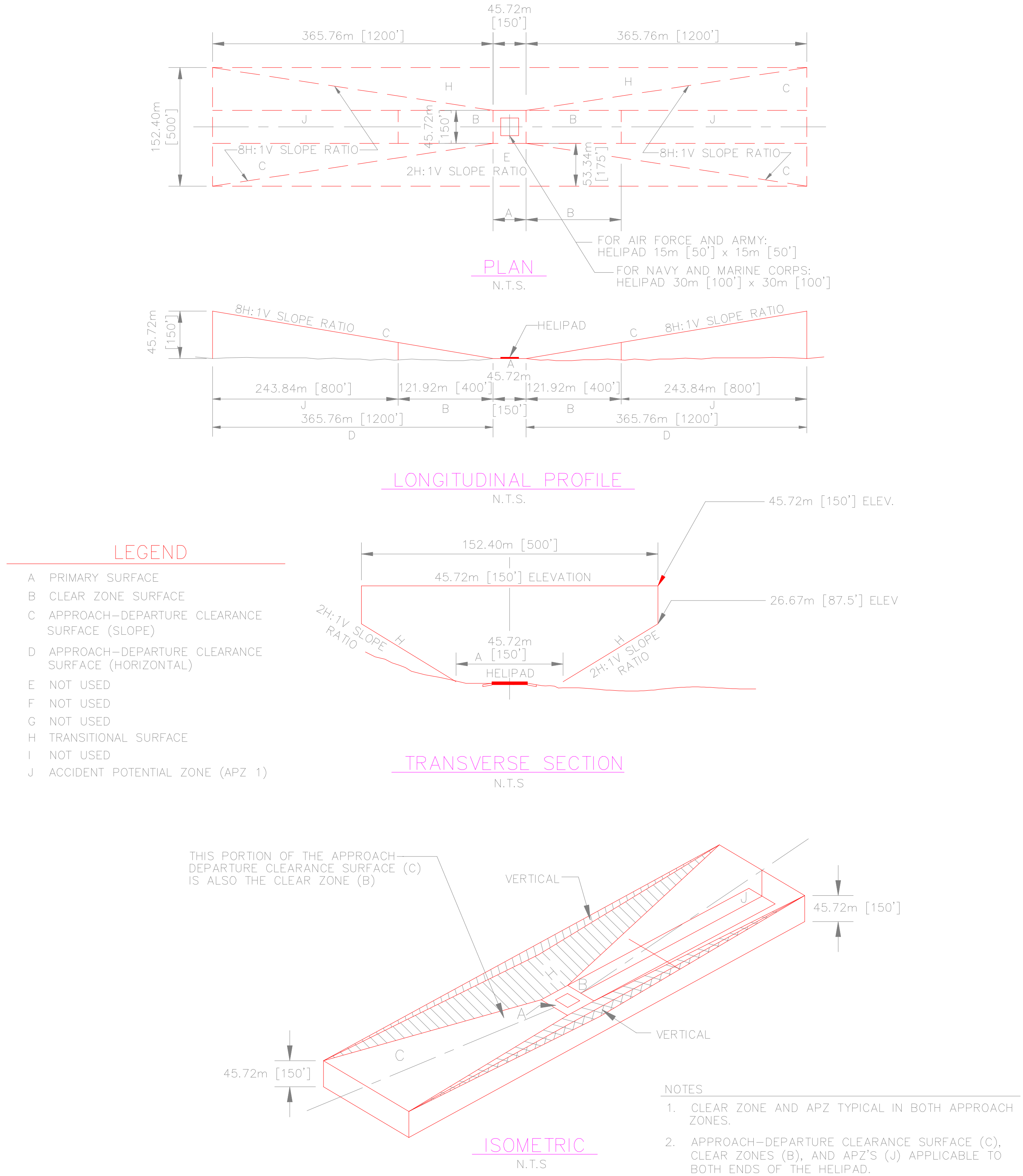
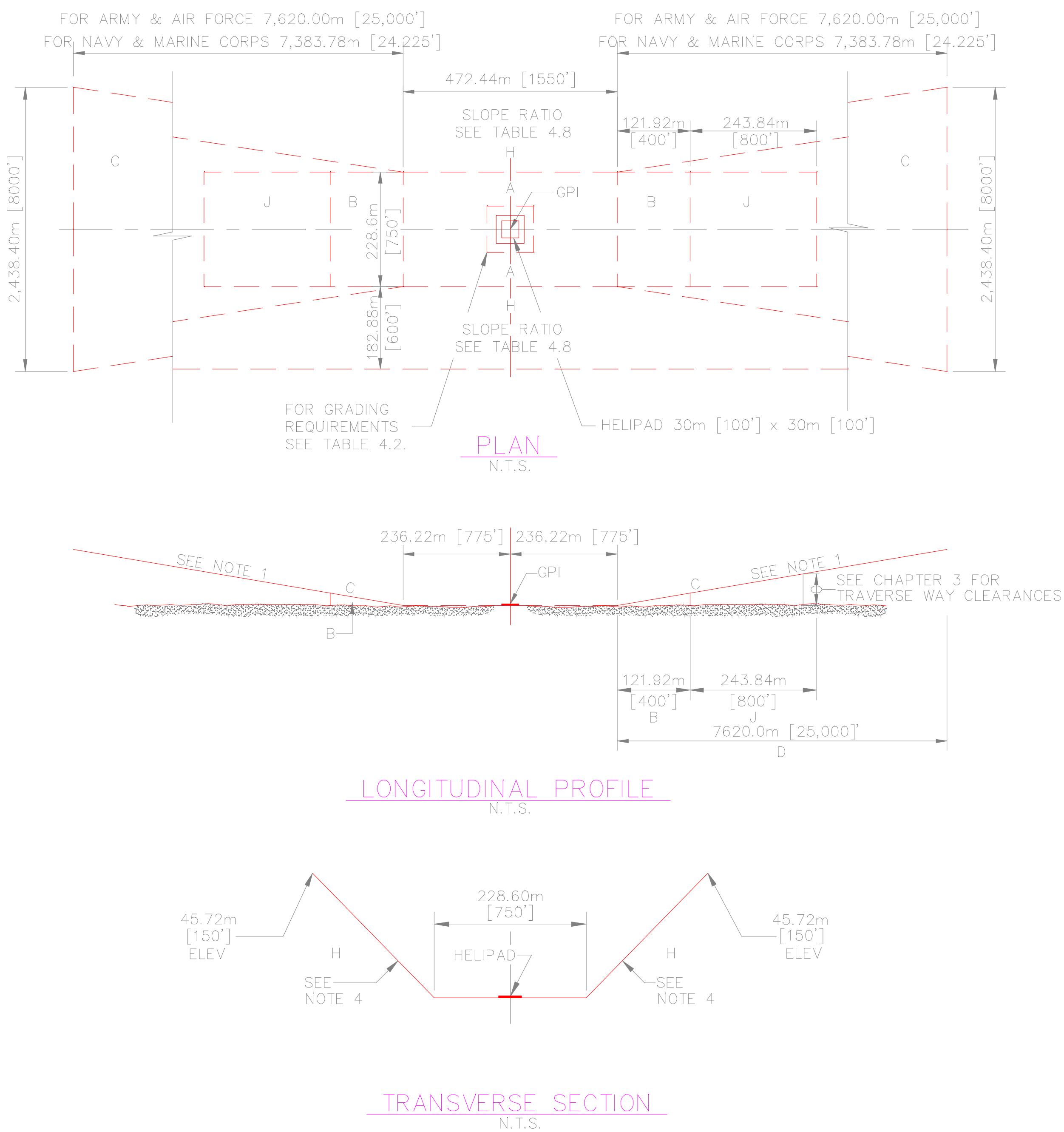


Figure 4.6. Standard IFR Helipad.



LEGEND

- A PRIMARY SURFACE
- B CLEAR ZONE SURFACE
- C APPROACH–DEPARTURE CLEARANCE SURFACE (SLOPE) SEE NOTE 1
- D APPROACH–DEPARTURE CLEARANCE SURFACE (HORIZONTAL)
- E INNER HORIZONTAL SURFACE (NOT SHOWN)
- F NOT USED
- G NOT USED
- H TRANSITIONAL SURFACE
- I NOT USED
- J ACCIDENT POTENTIAL ZONE (APZ 1)

NOTES

1. APPROACH–DEPARTURE CLEARANCE SURFACE SLOPE RATIO IS 34H:1V FOR ARMY AND AIR FORCE AND 25H:1V FOR NAVY AND MARINE CORPS.
2. CLEAR ZONE & APZ TYPICAL AT BOTH ENDS OF RUNWAY.
3. FOR ISOMETRIC, SEE FIGURE 4.3.
4. TRANSITIONAL SURFACE SLOPE RATIO IS 7H:1V FOR ARMY AND 4H:1V FOR ALL OTHERS.

Figure 4.7. Army and Air Force VFR Helipad with Same Direction Ingress/Egress.

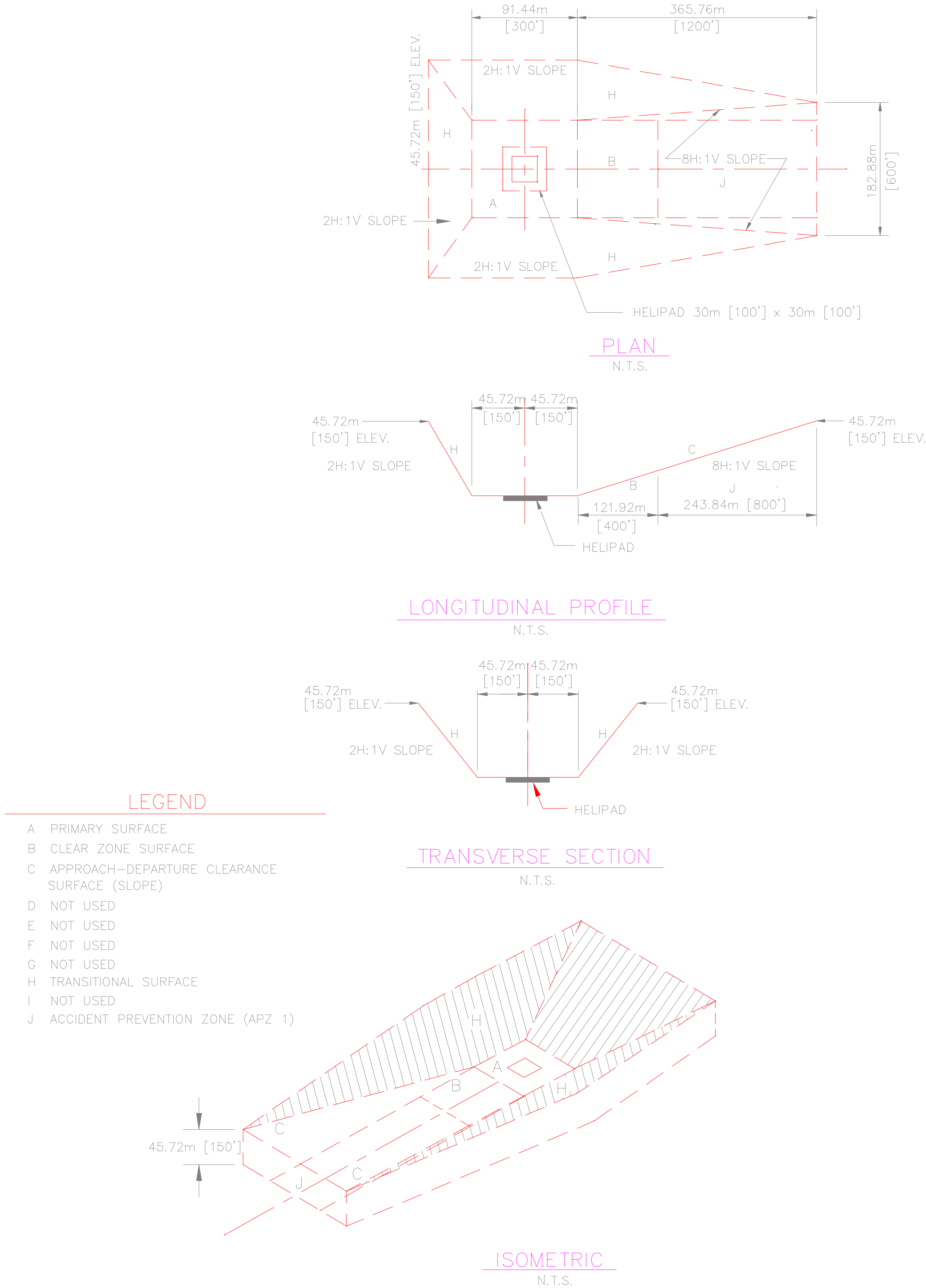


Figure 4.8. Army and Air Force IFR Helipad with Same Direction Ingress/Egress.

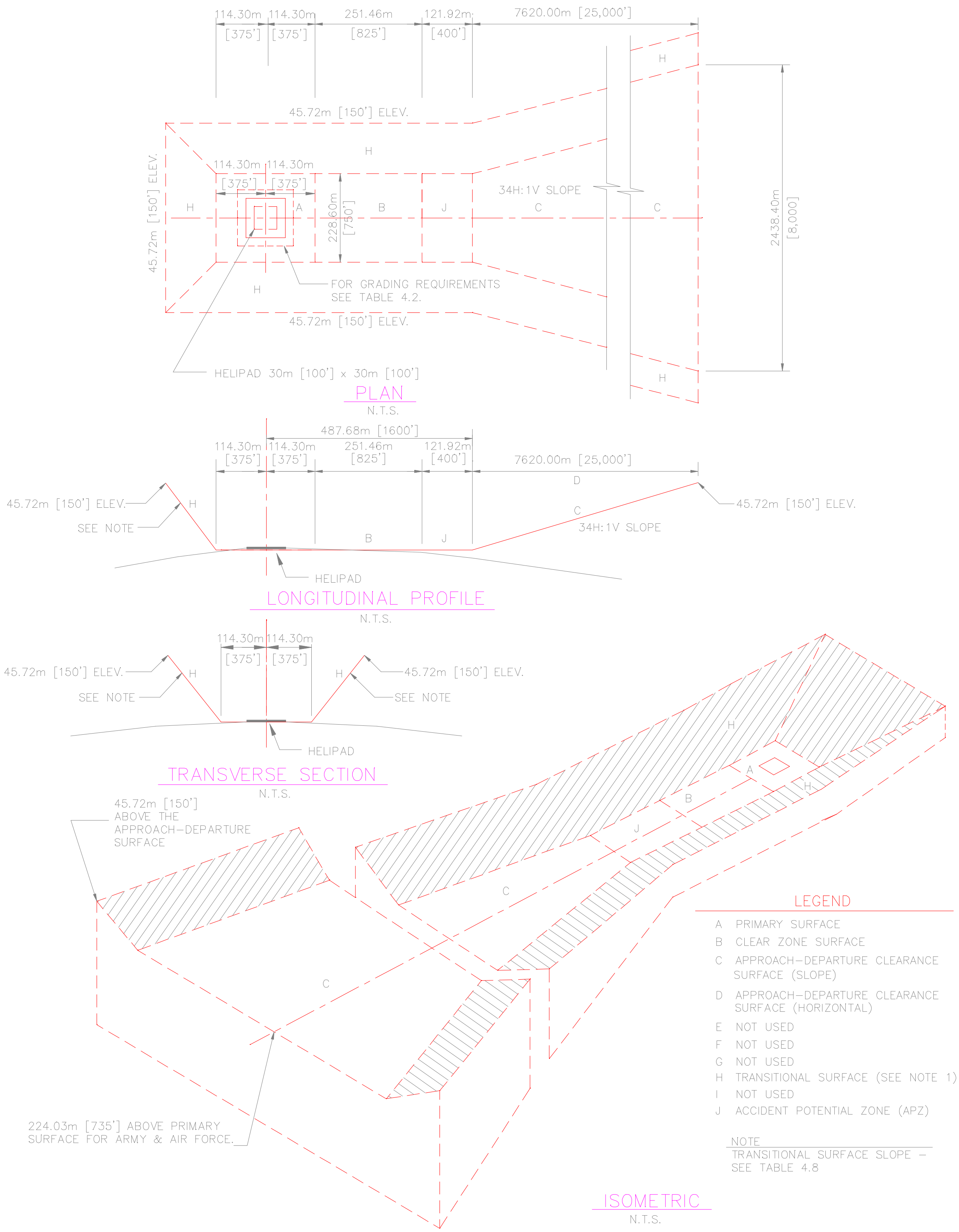
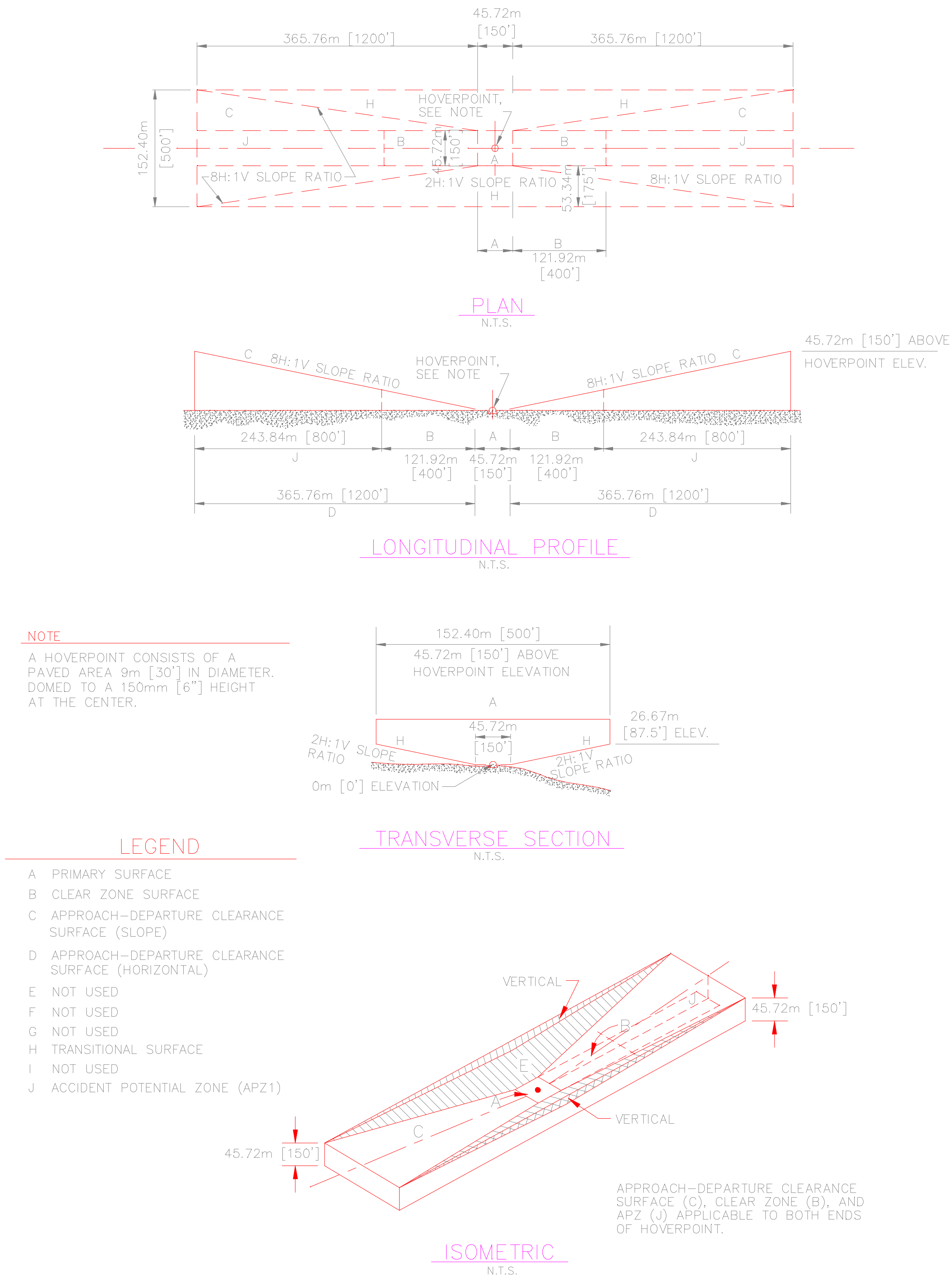


Figure 4.9. Helicopter Hoverpoint.



4.7.1. Requirements for a Landing Lane. Occasionally there are situations at airfields or heliports when a high density of helicopters are parked on mass aprons. When this occurs, there is usually a requirement to provide landing and take-off facilities that permit more numerous rapid launch and recovery operations that otherwise could be provided by a single runway or helipad. Increased efficiency can be attained by providing one or more of, but not necessarily limited to, the following:

4.7.1.1. Multiple helipads or hoverpoints.

4.7.1.2. A rotary-wing runway of length in excess of the criteria in Table 4.1.

4.7.1.3. Helicopter landing lanes.

4.7.2. Landing Lane Location. Landing lanes are located in front of the paved apron on which the helicopters park, as shown in Figure 4.9.

4.7.3. Touchdown Points. The location at which the helicopters are to touchdown on the landing lane are designated with numerical markings.

4.7.4. Dimensions. Table 4.3 presents dimensional criteria for the layout and design of rotary-wing landing lanes.

4.7.5. Layout. A layout for rotary-wing landing lanes is illustrated in Figure 4.10.

4.8. Air Force Helicopter Slide Areas or "Skid Pads." VFR helicopter runway criteria described in Table 4.1 and shown in Figures 4.1 and 4.3 (in terms of length, width, grade, and imaginary surfaces) are suitable for slide areas. The forces associated with helicopters landing at a small (but significant) rate of descent, and between 10 and 30 knots of forward velocity, require that slide area surfaces have both good drainage and some resistance to rutting. However, these landing surfaces need not be paved. Refer to AFJMAN 32-1014, *Pavement Design for Airfields*, for helicopter slide area structural criteria.

4.9. Shoulders for Rotary-Wing Facilities. Unprotected areas adjacent to runways and overruns are susceptible to erosion caused by rotor wash. The shoulder width for rotary-wing runways, helipads and landing lanes, shown in Table 4.4, includes both paved and unpaved shoulders. Paved shoulders are required adjacent to all helicopter operational surfaces including runways, helipads, landing lanes and hoverpoints. The unpaved shoulder must be graded to prevent water from ponding on the adjacent paved area. The drop-off next to the paved area prevents turf, which may build up over the years from ponding water. Rotary-wing facility shoulders are illustrated in Figures 4.1 through 4.10.

4.10. Overruns for Rotary-Wing Runways and Landing Lanes. Overruns are required at the end of all rotary-wing runways and landing lanes. Table 4.5 shows the dimensional requirements for overruns for rotary-wing runways and landing lanes. The pavement in the overrun is considered a paved shoulder. Rotary-wing overruns for runways and landing lanes are illustrated in Figures 4.1, 4.2 and 4.9.

4.11. Clear Zone and Accident Potential Zone (APZ). The Clear Zone and APZ are areas on the ground, located under the Rotary-Wing Approach-Departure surface. The Clear Zone and APZ are required for Rotary-Wing runways, helipads, landing lanes and hoverpoints.

Table 4.3. Rotary-Wing Landing Lanes.

Item No.	Item Description	Requirement	Remarks
1	Length	480 m [1,600 ft] to 600 m [2,000 ft]	Landing Lane length based on the number of touchdown points. Evenly space touchdown points along the landing lane.
2	Distance Between Touchdown Points on Landing Lane, Center-to-Center	120 m, min [400 ft, min]	Provide a number of equally spaced "touchdown" or holding points with adequate separation.
3	Width	23 m [75 ft]	
4	Paved Shoulders		See Table 4.4.
5	Distance Between Centerlines of Rotary-Wing Landing Lanes	60.96 m [200 ft]	For operations with an active operational air traffic control tower.
		91.44 m [300 ft]	For operations without an active operational air traffic control tower.
6	Landing Lane Lateral Clearance Zone (corresponds to half the width of primary surface area)	45.72 m [150 ft]	VFR facilities. Measured perpendicularly from centerline of runway to fixed or mobile obstacles. See Table 4.1, item 6 for obstacles definition.
		114.3 m (375 ft)	IFR facilities. Measured perpendicularly from centerline of runway to fixed or mobile obstacles. See Table 4.1, item 6 for obstacles definition.
7	Grades Within the Primary Surface Area in Any Direction	Min 2.0% Max 2.0%	Exclusive of pavement and shoulders.
8	Overrun	See Remarks	See Table 4.5
9	Clear Zone*	See Remarks	See Table 4.6.
10	APZ I*	See Remarks	See Table 4.6.
11	Distance Between Centerlines of a Fixed-Wing Runway and Landing Lane	See Table 4.1, Item 9	
		213.36 m min [700 ft min]	

* The clear zone area for Landing Lanes corresponds to the clear zone land use criteria for fixed-wing airfields as defined in DoD AICUZ standards. The remainder of the approach-departure zone corresponds to APZ I land use criteria similarly defined. APZ II criteria are not applicable for rotary-wing aircraft.

NOTES:

1. Metric units apply to new airfield construction and where practical modification to existing airfields and heliports, as discussed in paragraph 1.4.4.
2. The criteria in this manual are based on aircraft specific requirements and are not direct conversions from inch-pound (English) dimensions. Inch-pound units are included only as a reference to the previous standard.
3. Airfield and heliport imaginary surfaces and safe wingtip clearance dimensions are shown as a direct conversion from inch-pound to SI units.

Table 4.4. Shoulders for Rotary-Wing Facilities.

No.	Item Description	Requirement	Remarks
1	Total Width of Shoulders (Paved and Unpaved) Adjacent to All Operational Pavements	7.5 m [25 ft]	May be increased when necessary to accommodate dual operations with fixed-wing aircraft.
2	Paved Shoulder Width Next to All Operational Pavements	7.5 m [25 ft]	For Army and Air Force.
		0 m [0 ft]	For Navy and Marine Corps, except as noted.
3	Longitudinal Grade	Variable	Conform to the longitudinal grade of the abutting primary pavement.
4	Transverse Grade	2.0% min 4.0% max	Slope downward from edge of pavement.
5	Grade (adjacent to paved shoulder)	(a) 40 mm [1½ inch] drop off at edge of paved shoulder (b) 5% slope first 3 m [10 ft] Primary Surface criteria apply beyond this point.	Slope downward from edge of shoulder. See Table 4.1, Item No. 7 and Table 5.3, Item No. 5.

NOTES:

1. Metric units apply to new airfield construction and where practical modification to existing airfields and heliports, as discussed in paragraph 1.4.4.

2. The criteria in this manual are based on aircraft specific requirements and are not direct conversions from inch-pound (English) dimensions. Inch-pound units are included only as a reference to the previous standard.
3. Airfield and heliport imaginary surfaces and safe wingtip clearance dimensions are shown as a direct conversion from inch-pound to SI units.

Figure 4.10. Rotary-Wing Landing Lane.

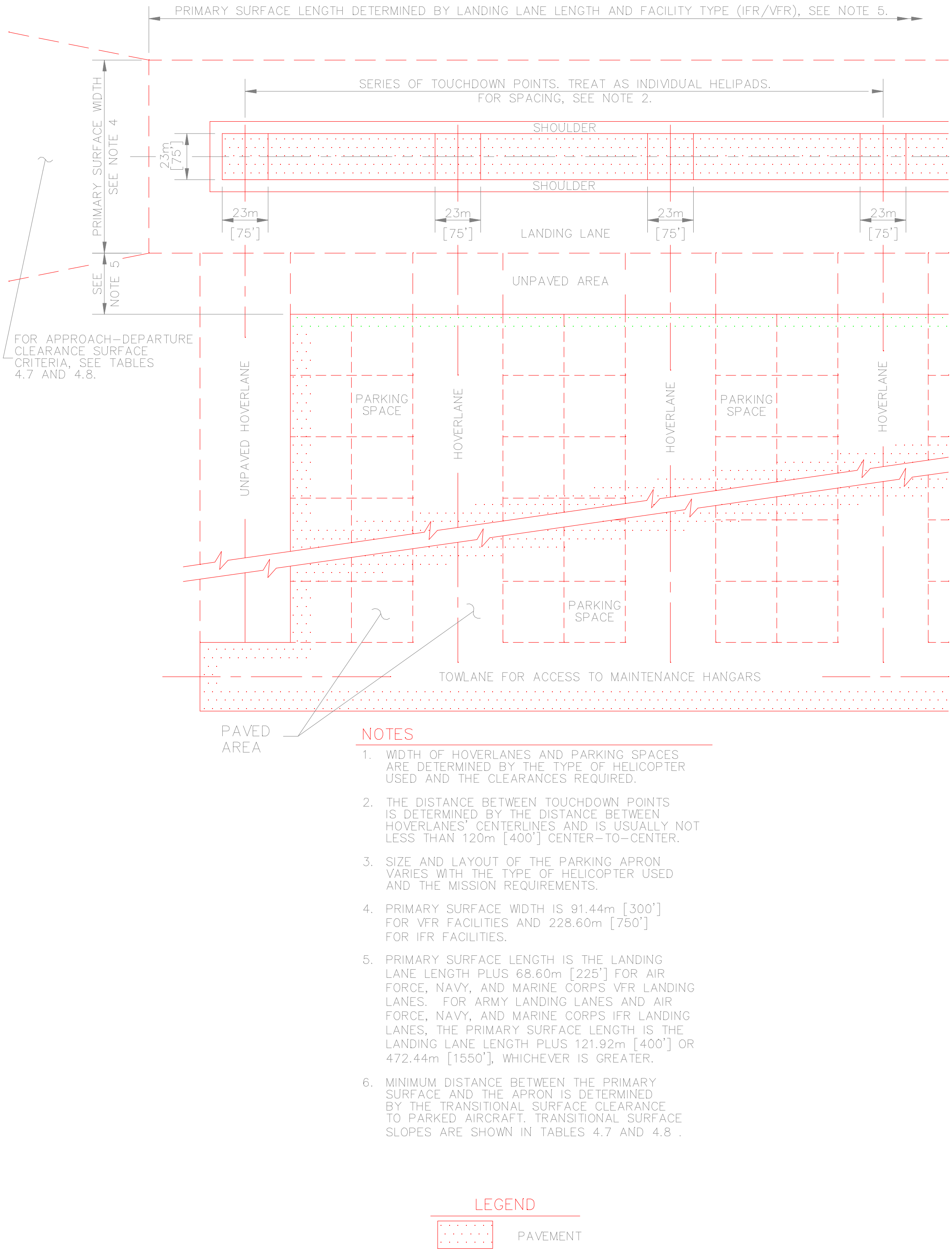


Table 4.5. Overruns for Rotary-Wing Runways and Landing Lanes.

No.	Item Description	Requirement	Remarks
1	Total Length (paved and unpaved)	23 m [75 ft]	
2	Paved Length of Overrun	7.5 m (25 ft)	Air Force and Army only.
3	Width	38 m [125 ft]	Width of runway plus paved shoulders. A minimum width of 45 meters [150 feet] for airfields which regularly accommodate H-53 aircraft (30 meter [100 feet] runway and 7.5 meter [25 feet] shoulders).
4	Longitudinal Centerline Grade	Max. 1.0%	Changes in longitudinal grade in overrun or between overrun and runway should not exceed 0.167% per 30 linear meters [100 linear feet].
5	Transverse Grade (paved and unpaved)	Min. 2.0% Max. 3.0%	Warp to meet runway and shoulder grades.

NOTES:

1. Metric units apply to new airfield construction and where practical modification to existing airfields and heliports, as discussed in paragraph 1.4.4.
2. The criteria in this manual are based on aircraft specific requirements and are not direct conversions from inch-pound (English) dimensions. Inch-pound units are included only as a reference to the previous standard.
3. Airfield and heliport imaginary surfaces and safe wingtip clearance dimensions are shown as a direct conversion from inch-pound to SI units.

4.11.1. Clear Zone Land Use. The Clear Zone for Rotary-Wing facilities must be free of obstructions, both natural and manmade, and rough-graded to minimize damage to an aircraft that runs off or lands short of the end of the landing surface. In addition, the Clear Zone permits recovery of aircraft that are aborted during take-off. The Clear Zone should be either owned or protected under a long term lease. Land use for the Clear Zone area for rotary-wing facilities corresponds to the Clear Zone land use criteria for fixed-wing airfields as defined for DoD AICUZ standards, and as discussed in Chapter 3 and Attachment 4.

4.11.2. Accident Potential Zone (APZ). Land use for the APZ area at rotary-wing facilities corresponds to the APZ land use criteria for fixed-wing airfields as defined in DoD AICUZ standards, and as discussed in Chapter 3 and Attachment 4. Ownership of the APZ is desirable but not required. If ownership is not possible, land use should be controlled through long-term lease agreements or local zoning ordinances.

4.11.3. Dimensions. Table 4.6 shows the dimensional requirements for the Clear Zone and APZ. These dimensions apply to rotary-wing runways, helipads, landing lanes and hoverpoints, depending on whether they support VFR or IFR operations. Layout of the Clear Zone and APZ are shown in Figures 4.1, 4.2 and 4.4 through 4.9.

4.12. Imaginary Surfaces for Rotary-Wing Runways, Helipads, Landing Lanes and Hoverpoints. Rotary-wing runways, helipads, landing lanes, and hoverpoints have imaginary surfaces similar to the imaginary surfaces for fixed-wing facilities. The imaginary surfaces are defined planes in space which establish clearance requirements for helicopter operations. An object, either manmade or natural, which projects through an imaginary surface plane is an obstruction to air navigation. Layout of the rotary-wing airspace imaginary surfaces are shown in Tables 4.7 and 4.8 and Figures 4.1 through 4.10. Rotary-wing airspace imaginary surfaces are defined in the glossary and summarized below:

4.12.1. Primary Surface.

4.12.2. Approach-Departure Clearance Surface (VFR).

4.12.3. Approach-Departure Clearance Surface (VFR Limited Use Helipads).

4.12.4. Approach-Departure Clearance Surface (IFR).

4.12.5. Horizontal Surface (IFR).

4.12.6. Transitional Surfaces.

Table 4.6. Rotary-Wing Runway and Landing Lane Clear Zone and Accident Potential Zone (APZ). (See Notes 1 and 2.)

No.	Item Description	Requirement	Remarks
1	Clear Zone Length	121.92 m [400 ft]	Clear Zone begins at the end of the primary surface.
2	Clear ZoneWidth (center width on extended runway/landing lane centerline) (corresponds to the width of the primary surface)	91.44 m [300 ft]	VFR rotary wing runways and landing lanes. See Note 2.
		228.60 m [750 ft]	IFR rotary-wing runways and landing lanes. See Note 2.
3	Grades in Clear Zone in Any Direction	2.0% Min. 5.0% Max.	Clear Zone only. Area to be free of obstructions. Rough grade and turf when required.
4	APZ I Length	243.84 m [800 ft]	See Notes 2 and 3.
5	APZ I Width	91.44 m [300 ft]	VFR rotary wing runways and landing lanes. See Notes 2 and 3.
		228.60 m [750 ft]	IFR Rotary-Wing Runways and Landing Lanes. See Notes 2 and 3.

NOTES:

1. The clear zone area for rotary wing runways and landing lanes corresponds to the clear zone land use criteria for fixed-wing airfields as defined in DoD AICUZ standards, and summarized in Attachment 4. The remainder of the approach-departure zone corresponds to APZ I land use criteria similarly defined. APZ II criteria is not applicable for rotary- wing aircraft.
2. Exceptions to these widths are permissible based on individual service analysis of highest accident potential area for specific rotary-wing runway/landing lane use and acquisition constraints.
3. No grading requirements for APZ I.
4. Metric units apply to new airfield construction and where practical modification to existing airfields and heliports, as discussed in paragraph 1.4.4.
5. The criteria in this manual are based on aircraft specific requirements and are not direct conversions from inch-pound (English) dimensions. Inch-pound units are included only as a reference to the previous standard.
6. Airfield and heliport imaginary surfaces and safe wingtip clearance dimensions are shown as a direct conversion from inch-pound to SI units.

Table 4.7. Rotary-Wing Imaginary Surface for VFR Approaches.

Item No.	Item Description	Legend in Figures	Helicopter Runway and Landing Lane	Helipad		Remarks
				Air Force and Army VFR Standard	Air Force and Army VFR Limited Use; Navy and Marine Corps Standard Helipad and Hoverpoints (see note 1)	Army does not have VFR Rotary-Wing Runways or Landing Lanes.
1	Primary Surface Width	A	91.44 m [300 ft]	91.44 m [300 ft]	45.72 m [150 ft]	Centered on the GPI.
2	Primary Surface Length	A	Runway or landing lane length plus 22.86 m [75 ft] at each end	91.44 m [300 ft] centered on facility	45.72 m [150 ft] centered on facility	Runway or landing lane length plus 30.48 (100 ft) at each end for Navy and Marine Corps facilities.
3	Primary Surface Elevation	A	The elevation of any point on the primary surface is the same as the elevation of the nearest point on the runway centerline or at the established elevation of the landing surface.			

4	Clear Zone Surface	B	See Table 4.6	See Table 4.2	See Table 4.2	
5	Start of Approach-Departure Surface	C	22.86 m [75 ft] from end of runway or landing lane	45.72 m [150 ft] from GPI	22.86 m [75 ft] from GPI	
6	Length of Sloped Portion of Approach-Departure Surface	C	365.76 m [1,200 ft]	365.76 m [1,200 ft]	365.76 m [1,200 ft]	Measured horizontally.
7	Slope of Approach-Departure Surface	C	8:1	8:1	8:1	Slope ratio is horizontal to vertical. 8:1 is 8 meters [feet] horizontal to 1 meter [foot] vertical.
8	Width of Sloped Portion of Approach-Departure Surface at Start of Sloped Portion	C	91.44 m [300 ft]	91.44 m [300 ft]	45.72 m [150 ft]	Centered on the extended center-line, and is the same width as the primary surface.
9	Width of Sloped Portion of Approach-Departure Surface at End of Sloped Portion	C	182.88 m [600 ft]	182.88 m [600 ft]	152.40 m [500 ft]	Centered on the extended center-line.
10	Elevation of Approach-Departure Surface at Start of Sloped Portion	C	0 m [0 ft]	0 m [0 ft]	0 m [0 ft]	Above the established elevation of the landing surface.
11	Elevation of Approach-Departure Surface at End of Sloped Portion	C	45.72 m [150 ft]	45.72 m [150 ft]	45.72 m (150 ft)	Above the established elevation of the landing surface.
12	Length of Approach-Departure Zone	D	365.76 m [1,200 ft]	365.76 m [1,200 ft]	365.76 m [1,200 ft]	Measured horizontally from the end of the primary surface and is the same length as the Approach-Departure Clear-ance Surface length.

13	Start of Approach-Departure Zone	D	22.86 m [75 feet] from end of runway	45.72 m [150 ft] from center of helipad	22.86 m [75 ft] from center of helipad	Starts at the end of the primary surface.
14	Transitional Surface Slope	H	2H:1V See Remark 1	2H:1V See Remark 1	2H:1V See Remark 2	(1) The transitional surface starts at the lateral edges of the primary surface and the approach-departure clearance surface. It contin-ues outward and upward at the prescribed slope to an elevation of 45.72 m (150 ft) above the estab-lished airfield elevation. (2) The transitional surface starts at the lateral edges of the primary surface and the approach-departure clearance surface. It con-tinues outward and upward at the prescribed slope to an elevation of 26.67 m (87.5 ft) above the estab-lished airfield elevation. It then rises vertically to an elevation of 45.7 m (150 ft) above the estab-lished airfield elevation. See Figures 4.5 and 4.10 for shape of transitional surfaces.
15	Horizontal Surface	G	Not Required	Not Required	Not Required	

NOTES:

1. Navy and Marine Corps do not have criteria for same direction ingress/egress.
2. Metric units apply to new airfield construction and where practical modification to existing airfields and heliports, as discussed in paragraph 1.4.4.
3. The criteria in this manual are based on aircraft specific requirements and are not direct conversions from inch-pound (English) dimensions. Inch-pound units are included only as a reference to the previous standard.
4. Airfield and heliport imaginary surfaces and safe wingtip clearance dimensions are shown as a direct conversion from inch-pound to SI units.

Table 4.8. Rotary-Wing Imaginary Surfaces for IFR Approaches.

Item No.	Item Description	Legend in Figures	Helicopter Runway and Landing Lanes	Helipad		Remarks
				Standard	Air Force and Army same direction ingress/egress; See Remarks.	Navy and Marine Corps do not have criteria for unidirectional ingress/egress.
1	Primary Surface Width	A	228.60 m [750 ft]	228.60 m [750 ft]	228.60 m [750 ft]	Centered on helipad.
2	Primary Surface Length	A	The greater distance of: runway length plus 60.96 m [200 ft] at each end; or 472.44 m [1,550 ft]	472.44 m [1,550 ft] centered on GPI	114.3 m [375 ft] centered on GPI	
3	Primary Surface Elevation	A	The elevation of any point on the primary surface is the same as the elevation of the nearest point on the runway or landing lane centerline or established elevation of the helipad.			
4	Clear Zone Surface	B	See Table 4.6	See Table 4.2	See Table 4.2	
5	Start of Approach-Departure Surface	C	Measured from the center of the runway, the greater distance of: ½ runway length plus	236.22 m [775 ft] from GPI	487.68 m [1,600 ft] from GPI	Army and Air Force facilities.

			60.96m [200 ft]; or 236.22m [775 ft]			
			236.22 m [775 ft] from GPI.	236.22 m [775 ft] from GPI.	NA	Navy and Marine Corps facilities.
			See Remarks	See Remarks	See Remarks	Starts at the end of the primary surface.
6	Length of Sloped Portion of Approach-Departure Surface	C	7,620.00 m [25,000 ft]	7,620.00 m [25,000 ft]	7,620.00 m [25,000 ft]	For Army and Air Force facilities.
			7,383.78 m [24,225 ft]	7,383.78 m [24,225 ft]	NA	For Navy and Marine Corps facilities.
			See Remarks	See Remarks	See Remarks	Measured horizontally
7	Slope of Approach-Departure Surface	C	34:1	34:1	34:1	For Army and Air Force Facilities.
				Standard	Air Force and Army unidirection-al ingress/egress; See Remarks.	Navy and Marine Corps do not have criteria for unidirectional ingress/egress.
			25:1	25:1	NA	For Navy and Marine Corps facilities.
			See Remarks	See Remarks	See Remarks	Slope ratio is horizontal to vertical. 34:1 is 34 meters [feet] horizontal to 1 meter [foot] vertical.
8	Width of Approach-Departure Surface at Start of Sloped Portion	C	228.60 m [750 ft]	228.60 m [750 ft]	228.60 m [750 ft]	Army and Air Force facilities.
			228.60 m [750 ft]	228.60 m [750 ft]	NA	Navy and Marine Corps facilities.
			See Remarks	See Remarks	See Remarks	Centered on the extended centerline and is the same width as the primary surface.

9	Width of Approach-Departure Surface at End of Sloped Portion	C	2,438.60 m [8,000 ft]	2,438.60 m [8,000 ft]	2,438.60 m [8,000 ft]	Army and Air Force facilities.
			2,438.60 m [8,000 ft]	2,438.60 m [8,000 ft]	NA	Navy and Marine Corps facilities.
			See Remarks	See Remarks	See Remarks	Centered on the extended centerline.
10	Elevation of Approach-Departure Surface at Start of Sloped Portion	C	0 m [0 ft]	0 m [0 ft]	0 m [0 ft]	Army and Air Force facilities.
			0 m [0 ft]	0 m [0 ft]	NA	Navy and Marine Corps facilities.
			See Remarks	See Remarks	See Remarks	Above the established elevations of the landing surface.
				Standard	Air Force and Army unidirectional ingress/egress; See Remarks.	Navy and Marine Corps do not have criteria for unidirectional ingress/egress.
11	Elevation of Approach-Departure Clearance Surface at End of Sloped Portion	C	224.03 m (735 ft)			Air Force and Army.
			295.35 m (969 ft)	N/A		Navy and Marine Corps.
			See Remarks			Above the established elevation of the landing surface.
12	Transitional Surface Slope	H	7:1	7:1	7:1	Army
			4:1	4:1	7:1	Air Force
			4:1	4:1	N/A	Navy and Marine Corps
			See Remarks			See Figures 4.2, 4.6, 4.7, and 4.8 for shape of Transitional Surface.The Transitional Surface starts at the lateral edges of the primary surface and the approach-departure clearance surface. It continues outward and upward at the prescribed slope to 45.72 m (150 ft) above the established airfield elevation.

13	Horizontal Surface Radius	E	1,143 m [3,750 ft]for 25:1 approach-departure surfaces	N/A	N/A	An imaginary surface located 45.72 m [150’] above the established heliport elevation, formed by scribing an arc about the end of each runway or landing lane, and inter-connecting these arcs with tangents.
			1,554.48m (5,100 ft) for 34:1 approach-departure surfaces	N/A	N/A	
			N/A	1,402.08 m [4,600 ft]	1,402.08 m [4,600 ft]	Circular in shape, located 45.72 m [150 ft] above the established heliport or helipad elevation, defined by scribing an arc with a 1,402.08 m [4,600 ft] radius about the center point of the helipad.
14	Elevation of Horizontal Surface	H	45.72 m [150 ft]	45.72 m [150 ft]	45.72 m [150 ft]	

NOTES:

1. Metric units apply to new airfield construction and where practical modification to existing airfields and heliports, as discussed in paragraph 1.4.4.
2. The criteria in this manual are based on aircraft specific requirements and are not direct conversions from inch-pound (English) dimensions. Inch-pound units are included only as a reference to the previous standard.
3. Airfield and heliport imaginary surfaces and safe wingtip clearance dimensions are shown as a direct conversion from inch-pound to SI units.

4.13. Obstructions and Airfield Airspace Criteria. If the imaginary surface around a rotary-wing runway, helipad, landing lane, and hoverpoint is penetrated by manmade or natural objects as defined in Attachment 6, the penetrating object is an obstruction. Determination and dealing with obstructions are further discussed in Attachment 6.

Chapter 5

TAXIWAYS

5.1. Contents. This chapter presents design standards and considerations for fixed- and rotary-wing taxiways.

5.2. Taxiway Requirements. Taxiways provide for ground movement of fixed- and rotary-wing aircraft. Taxiways connect the runways of the airfield with the parking and maintenance areas and provide access to hangars, docks, and various parking aprons and pads. Taxiways are designated alphabetically, avoiding the use of I, O, and X. Alphanumerics may be used when necessary; e.g. A1, B3.

5.3. Taxiway Systems:

5.3.1. Basic. The basic airfield layout consists of a taxiway connecting the center of the runway with the parking apron. This system limits the number of aircraft operations at an airfield. Departing aircraft must taxi on the runway to reach the runway threshold. When aircraft are taxiing on the runway, no other aircraft is allowed to use the runway. If runway operations are minimal or capacity is low, the basic airfield layout with one taxiway may be an acceptable layout.

5.3.2. Parallel Taxiway. A taxiway parallel for the length of the runway, with connectors to the end of the runway and parking apron, is the most efficient taxiway system. Aircraft movement is not hindered by taxiing operations on the runway and the connectors permit rapid entrance and exit of traffic.

5.3.3. High Speed Taxiway Turnoff. High speed taxiway turnoffs are located intermediate of the ends of the runway to increase the capacity of the runway. The high-speed taxiway turnoff enhances airport capacity by allowing aircraft to exit the runways at a faster speed than turnoff taxiways allow.

5.3.4. Additional Types of Taxiways. Besides the types of taxiways discussed above, there are other taxiways at an airfield. Taxiways are often referred to based on their function. Common airfield taxiways and their designations are shown in Figure 5.1.

5.3.5. Taxilanes. A taxi route through an apron is referred to as a taxilane. Taxilanes are further discussed in Chapter 6 for the Army and Air Force, and MIL-HDBK-1021/1 for the Navy and Marine Corps.

5.4. Taxiway Layout. The following should be considered when planning and locating taxiways at an airfield:

5.4.1. Efficiency. Runway efficiency is enhanced by planning for a parallel taxiway.

5.4.2. Direct Access. Taxiways should provide as direct an access as possible from the runway to the apron. Connecting taxiways should be provided to join the runway exit points to the apron.

5.4.3. Simple Taxiing Routes. A sufficient number of taxiways should be provided to prevent complicated taxiing routes. Turning from one taxiway on to another often creates confusion and may require additional airfield signs and communication with the air traffic control tower.

5.4.4. Prevent Delays. A sufficient number of taxiways should be provided to prevent capacity delays which may result when one taxiway must service more than one runway.

5.4.5. Runway Exit Criteria. The number, type, and location of exits is a function of runway length, as shown in Figure 5.2 and as discussed in Chapter 2.

Figure 5.1. Common Taxiway Designations.

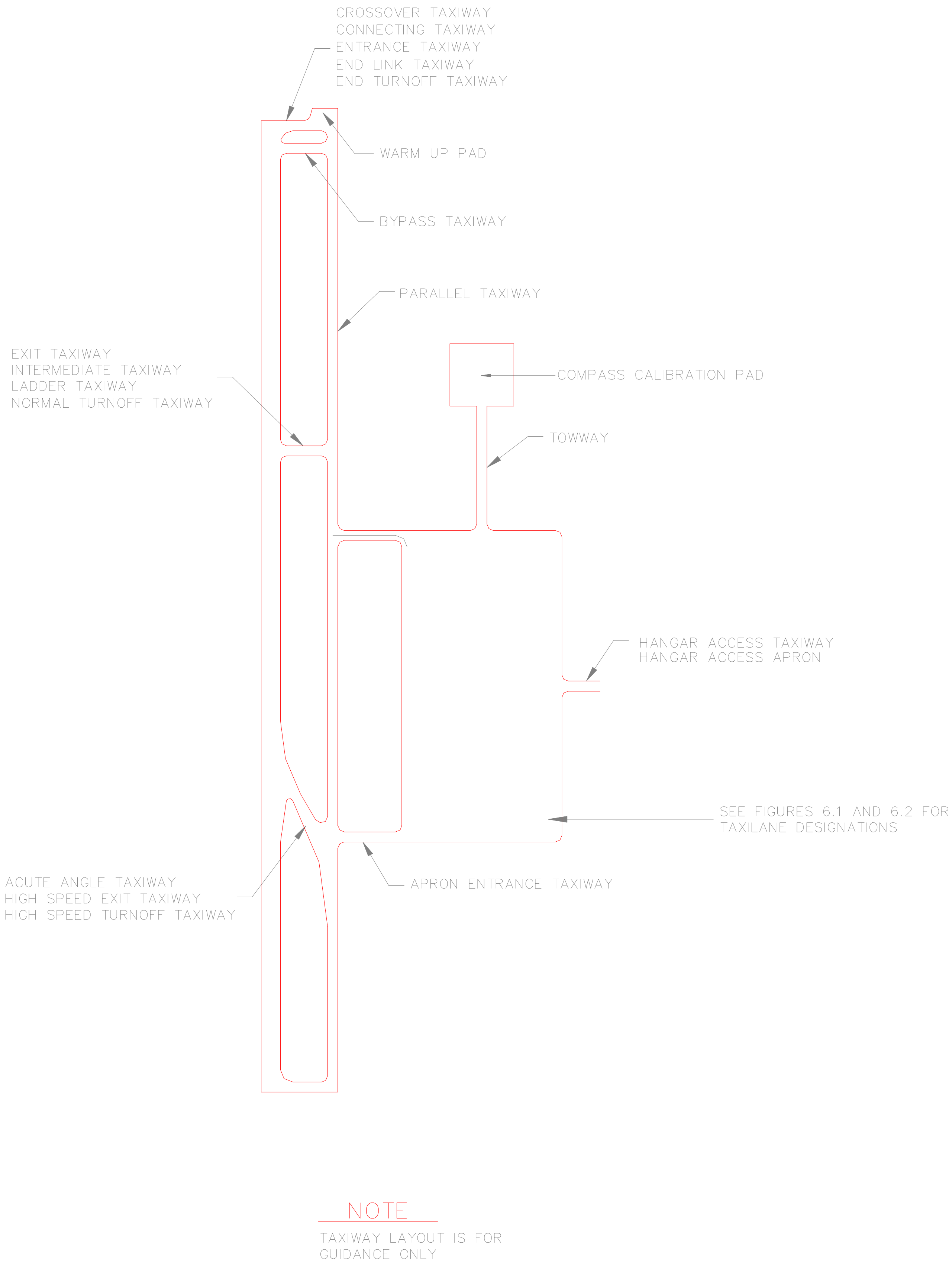
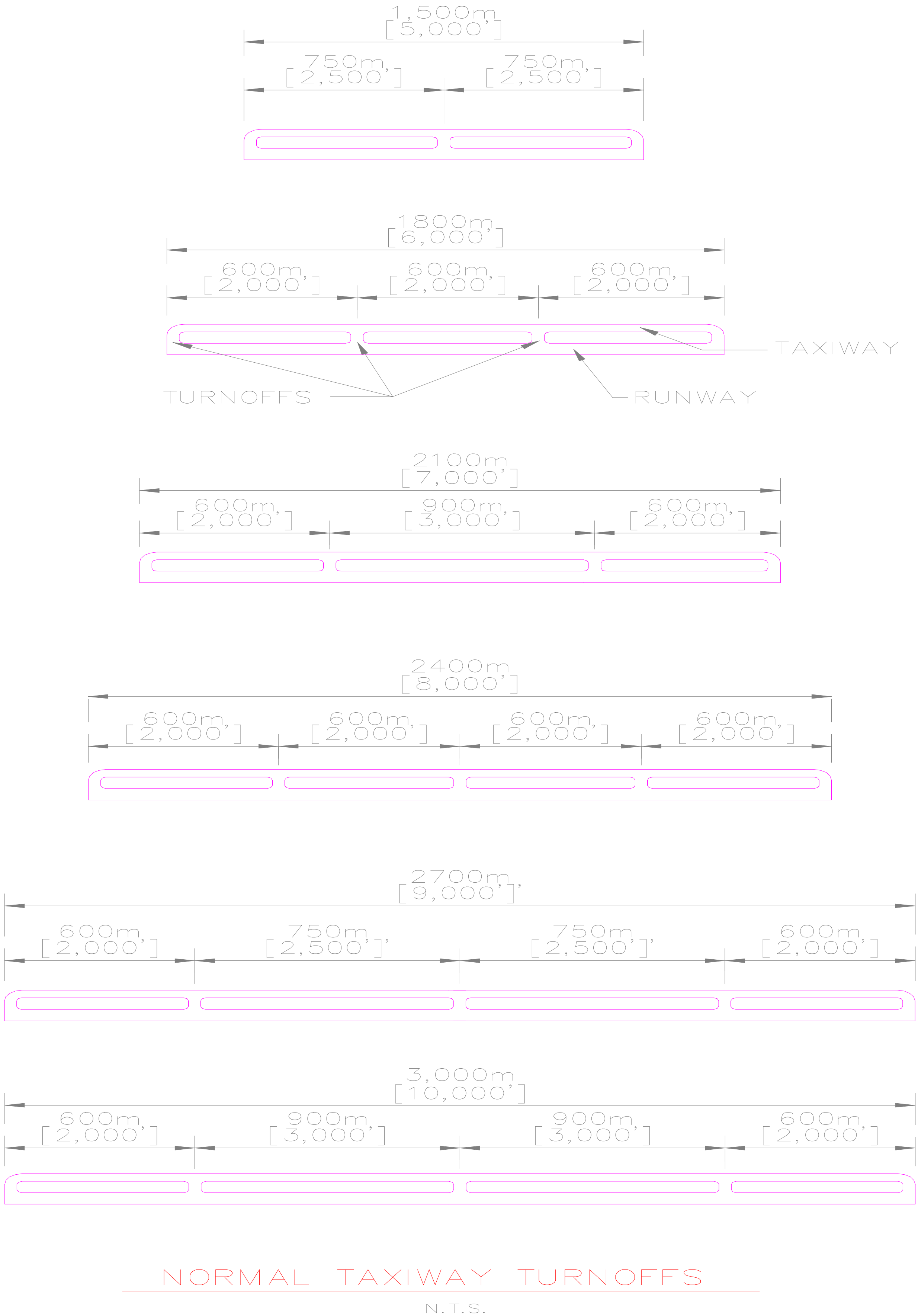


Figure 5.2. Spacing Requirements - Normal Taxiway Turnoffs.



5.5. Fixed-Wing Taxiway Dimensions. Taxiway dimensions are based on the class of runway which it serves.

5.5.1. Criteria. Table 5.1 presents the criteria for fixed-wing taxiway design, including clearances, slopes and grading dimensions.

5.5.2. Transverse Cross-Section. A typical transverse cross-section of a taxiway is shown in Figure 5.3.

Table 5.1. Fixed-Wing Taxiways.

Item No.	Item Description	Class A Runway	Class B Runway	Remarks
		Requirement		
1	Width	15 m [50 ft]	23 m [75 ft]	Army and Air Force airfields.
		12 m [40 ft]	23 m [75 ft]	Navy and Marine Corps airfields.
		See Remarks		May be modified for particular mission requirements (special taxiways such as high speed and end turn-off).
2	Total Width of Shoulders (paved and unpaved)	7.5 m [25 ft]	15 m [50 ft]	
3	Paved Shoulder Width (See note 3.)	7.5 m [25 ft]	7.5 m [25 ft]	Army and Air Force airfields except as noted below.
		NA	3 m [10 ft]	Air Force airfields for fighter and trainer aircraft. A paved shoulder up to 7.5 m (25 ft) is allowed on the outside of taxiway turns of 90 degrees (90º) or more.
		NA	15 m [50 ft]	Airfields for B-52 Aircraft.
		NA	Not Required	Navy and Marine Corps airfields.
4	Longitudinal Grade of Taxiway and Shoulders	Max 3.0%		Grades may be both positive and negative but must not exceed the limit specified. For Navy and Marine Corps airfields, a maximum of 2.0% is recommended when jet aircraft are required to accelerate from a standing position.

				For Air Force airfields other than multimission, a gradient exception of 5.0 % is permitted for a distance of not more than 120 m [400 ft]. The exception does not apply within 180 m [600 ft] of a runway entrance. Here the 3.0% maximum applies. For Air Force multimission airfield, the gradient is limited to 1.5%.
5	Rate of Longitudinal Grade Change per 30 m [100 ft]	Max 1.0%		The minimum distance between two successive points of intersection (PI) is 150 m [500 ft]. Changes are to be accomplished by means of vertical curves.
6	Longitudinal Sight Distance	Min 600 m [2,000 ft]between eye level at 2.14 m [7 ft] and an object 3.05 m [10 ft] above taxiway pavement		Army, Navy and Marine Corps airfield taxiways.
		Min 300 m [1,000 ft]. Any two points 3 m [10 ft] above the pavement must be mutually visible for the distance indicated.		Air Force airfield taxiways.
7	Transverse Grade of Taxiway	Min 1.0% Max 1.5%		New taxiway pavements will be centerline crowned. Slope pavement downward from centerline of taxiway. Existing taxiway pavements with insufficient transverse gradients for rapid drainage should provide for increased gradients when overlaid or reconstructed. The transverse gradients requirements are not applicable at or adjacent to intersections where pavements must be warped to match abutting pavements.
8	Transverse Grade of Paved Shoulders	Min 2.0% Max 4.0%		Army, Navy, Marine Corps and Air Force airfields, not otherwise specified.
		NA	Min 1.5% Max 2.0%	Air Force taxiway designed for B-52 aircraft.

9	Transverse Grade of Unpaved Shoulders	(a) 40 mm [1½"] drop off at edge of pavement (b) 5% slope first 3 m [10 ft] from paved shoulder or runway edge where no paved shoulder (c) Beyond 3 m [10 ft] from paved shoulder, 2.0% min, 4.0% max		For additional information, see Figure 3.1.
10	Clearance from Taxiway Centerline to Fixed or Mobile Obstacles (taxiway clearance line)	Min 45.72 m [150 ft]		Army, Navy and Marine Corps airfields.
		Min 45.72 m [150 ft]	Min 60.96 m [200 ft]	Air Force airfields.
		See Remarks		See Table 3.2, Item No. 12 for obstacle definition.
11	Distance Between Taxiway Centerline and Parallel Taxiway/Taxilane Centerline	53 m [175 ft]	57 m [187.5 ft] or wingspan + 15 m [wingspan + 50 ft], whichever is greater	Army airfields.
		53 m [175 ft]	73 m [237.5 ft] or wingspan + 15 m [wingspan + 50 ft], whichever is greater	Air Force and Navy airfields.
12	Grade (area between taxiway shoulder and taxiway clearance line)		Min of 2.0% prior to channelization Max 10.0%[2]	Army, Air Force, Navy, and Marine Corps airfields, except as noted below. For additional information, see Figure 3.1. Slope from shoulder pavement.
		(a) 40 mm [1½"] drop off at edge of paved shoulder (b) 5% slope first 3 m [10 ft] from paved shoulder (c) Beyond 3 m [10 ft] from paved shoulder, 2.0% min, prior to channelization, 10.0% max (See note 2.)		Class A airfields and Air Force taxiways designed for B-52 aircraft. For additional information, see Figure 3.1. Slope away from shoulder pavement.

NOTES:

1. NA = Not Applicable

2. Bed of channel may be flat.
3. A 15 m (50 ft) paved shoulder is allowed for C-5, C-4, and 747 aircraft where vegetation cannot be established.
4. Metric units apply to new airfield construction and where practical modification to existing airfields and heliports, as discussed in paragraph 1.4.4.
5. The criteria in this manual are based on aircraft specific requirements and are not direct conversions from inch-pound (English) dimensions. Inch-pound units are included only as a reference to the previous standard.
6. Airfield and heliport imaginary surfaces and safe wingtip clearance dimensions are shown as a direct conversion from inch-pound to SI units.

5.6. Rotary-Wing Taxiway Dimensions. Rotary-wing taxiways are either paved or unpaved. Wheel-gear configured rotary wing aircraft require a paved surface on which to taxi. Skid-gear configured rotary-wing aircraft taxi by hovering along a paved or unpaved taxiway. Table 5.2 presents the criteria for rotary-wing taxiway design, including taxiway widths, clearances, slopes and grading dimensions.

5.7. Taxiways at Dual Use (Fixed- and Rotary-Wing) Airfields:

5.7.1. Criteria. For taxiways at airfields supporting both fixed- and rotary-wing aircraft operations, the appropriate fixed-wing criteria will be applied, except as noted for shoulders.

5.7.2. Taxiway Shoulders. A paved shoulder will be provided at dual use airfields. Shoulder widths may be increased beyond the requirement presented in Table 5.3, when necessary, to accommodate dual operations with fixed-wing aircraft.

5.8. Taxiway Intersection Criteria. To prevent the main gear of an aircraft from becoming dangerously close to the outside edge of the taxiway during a turn, fillets and lead-in to fillets are provided at taxiway intersections. When an aircraft turns at an intersection, the nose gear of the aircraft usually follows the painted centerline marking. The main gears, located to the rear of the nose gear, do not remain a constant distance from the centerline stripe during the turn due to the physical design of the aircraft. The main gears pivot on a shorter radius than the nose gear during a turn.

Figure 5.3. Taxiway and Primary Surface Transverse Sections.

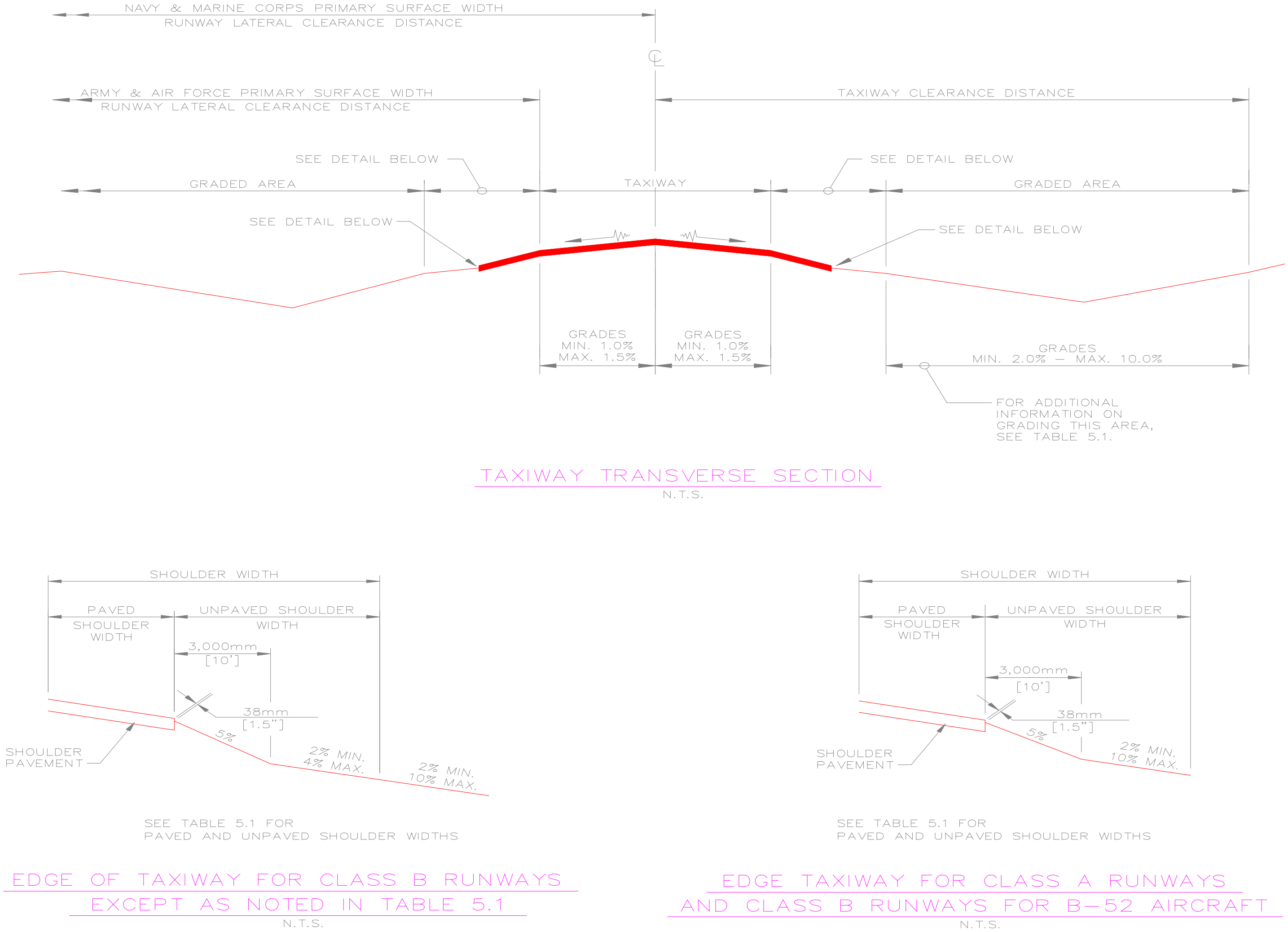


Table 5.2. Rotary-Wing Taxiways.

Item No.	Item Description	Requirement	Remarks
1	Width	15 m [50 ft]	Army and Air Force facilities.
		12 m [40 ft]	Navy and Marine Corps facilities.
		See Remarks	Basic width applicable to taxiways that support helicopter operations only. When dual use taxiways support fixed-wing aircraft operations, use the appropriate fixed-wing criteria.
2	Longitudinal Grade	Max 2.0%	
3	Transverse Grade	Min 1.0% Max 1.5%	
4	Paved Shoulders		See Table 4.4.
5	Clearance from Centerline to Fixed and Mobile Obstacles (taxiway clearance line)	Min 30.48 m [100 ft]	Basic helicopters clearance. Increase as appropriate for dual use taxiways. See Table 3.2, Item No. 12 for definitions of fixed and mobile obstacles.
6	Grades Within the Clear Area	Max 5.0%	Clear area is the area between the taxiway shoulder and the taxiway clearance line.

NOTES:

1. Metric units apply to new airfield construction and where practical modification to existing airfields and heliports, as discussed in paragraph 1.4.4.
2. The criteria in this manual are based on aircraft specific requirements and are not direct conversions from inch-pound (English) dimensions. Inch-pound units are included only as a reference to the previous standard.
3. Airfield and heliport imaginary surfaces and safe wingtip clearance dimensions are shown as a direct conversion from inch-pound to SI units.

Table 5.3. Rotary-Wing Taxiway Shoulders.

Item No.	Item Description	Requirement	Remarks
1	Total Width of Shoulder (Paved and Unpaved)	7.5 m [25 ft]	May be increased when necessary to accommodate dual operations with fixed-wing aircraft.
2	Paved Shoulder Width Adjacent to All Operational Pavements	7.5 m [25 ft]	May be increased when necessary to accommodate dual operations with fixed-wing aircraft.
3	Longitudinal Grade	Variable	Conform to the longitudinal grade of the abutting primary pavement.

4	Transverse Grade	2.0% min 4.0% max	Slope downward from edge of pavement.
5	Grade (adjacent to paved shoulder)	(a) 40 mm [1½"] dropoff at edge of paved shoulder. (b) 5% slope first 3 m [10 ft] from paved shoulder.	Slope downward from edge of shoulder. For additional grading criteria in primary surface and clear area, see Chapter 3 for fixed-wing facilities and Chapter 4 for rotary-wing facilities.

NOTES:
1. Metric units apply to new airfield construction and where practical modification to existing airfields and heliports, as discussed in paragraph 1.4.4.
2. The criteria in this manual are based on aircraft specific requirements and are not direct conversions from inch-pound (English) dimensions. Inch-pound units are included only as a reference to the previous standard.
3. Airfield and heliport imaginary surfaces and safe wingtip clearance dimensions are shown as a direct conversion from inch-pound to SI units.

5.8.1. Fillet Only Dimensions. At Army and Air Force aviation facilities, and at Navy and Marine Corps facilities not serving large transport aircraft, only fillets (not lead-in to fillets) are required at intersections. Fillets at taxiway intersections are arcs installed in accordance with Figure 5.4.

5.8.2. Fillet and Lead-in to Fillet Dimensions. At Navy and Marine Corps aviation facilities with Class B runways serving large transport aircraft, fillets and lead-in to fillets are required at intersections. Lead-in to fillets widen the taxiway immediately to an intersection. Fillets and lead-in to fillets are installed in accordance with Figure 5.5.

5.9. High-Speed Runway Exits. If peak operations are expected to exceed 30 take-offs and landings per hour, aircraft may be required to exit runways at greater than normal taxi speeds to maintain airfield capacity. In these cases, an acute-angle exit taxiway may be required. Air Force designers should contact their MAJCOM pavements engineer or HQ AFCESA/CESC for assistance. Army designers shold contact CEMRO-ED-TX. Navy and Marine Corps designers may use the criteria for transport aircraft provided within Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5300-13, *Airport Design*.

5.10. Apron Access Taxiways. Apron access taxiways are provided for aircraft access onto an apron. The number of apron taxiways should allow sufficient capacity for departing aircraft. The apron access taxiways should be located to enhance the aircraft's departing sequence and route.

5.10.1. Parking Aprons. The minimum number of apron access taxiways for any parking apron will be two.

5.10.2. Fighter Aircraft Aprons. Three apron access taxiways should be provided for aprons with over 24 parked fighter aircraft. Four entrance taxiways should be provided for aprons with over 48 parked fighter aircraft.

5.11. Shoulders. Shoulders are provided along a taxiway to allow aircraft to recover if they leave the paved taxiway. Paved shoulders prevent erosion caused by jet blast, support an occasional aircraft which may wander off the taxiway, support vehicular traffic, and reduce maintenance of unpaved shoulder areas.

5.11.1. For Fixed-Wing Taxiways. The shoulder for fixed-wing taxiways may be either paved or unpaved, depending on the agency, class of runway and type of aircraft. Paved shoulder dimensions along fixed-wing taxiways are presented in Table 5.1. Criteria for fixed-wing taxiway shoulders, including widths and grading requirements to prevent the ponding of storm water, are presented in Table 5.1.

5.11.2. For Rotary-Wing Taxiways. Paved shoulders are required adjacent to rotary-wing taxiways to prevent blowing dust and debris due to prop-wash. The criteria for a rotary-wing taxiway shoulder layout, including shoulder width, cross slopes and grading requirements, are presented in Table 5.3.

Figure 5.4. Intersection Geometry for Army and Air Force Facilities, and Navy and Marine Corps Facilities Serving Aircraft with Wingspan Less Than 33.5 meters (110 feet).

RUNWAY WIDTH	FILLET RADIUS	FILLET RADIUS	FILLET RADIUS	FILLET RADIUS
W	R1	R2	R3	R4
LESS THAN 46m [150']	30m [100']	30m [100']	23m [75']	60m [200']
46m [150']	38m [125']	30m [100']	29m [95']	76m [250']
60m [200']	105m [350']	30m [100']	79m [260']	198m [650']
90m [300']	105m [350']	30m [100']	79m [260']	198m [650']

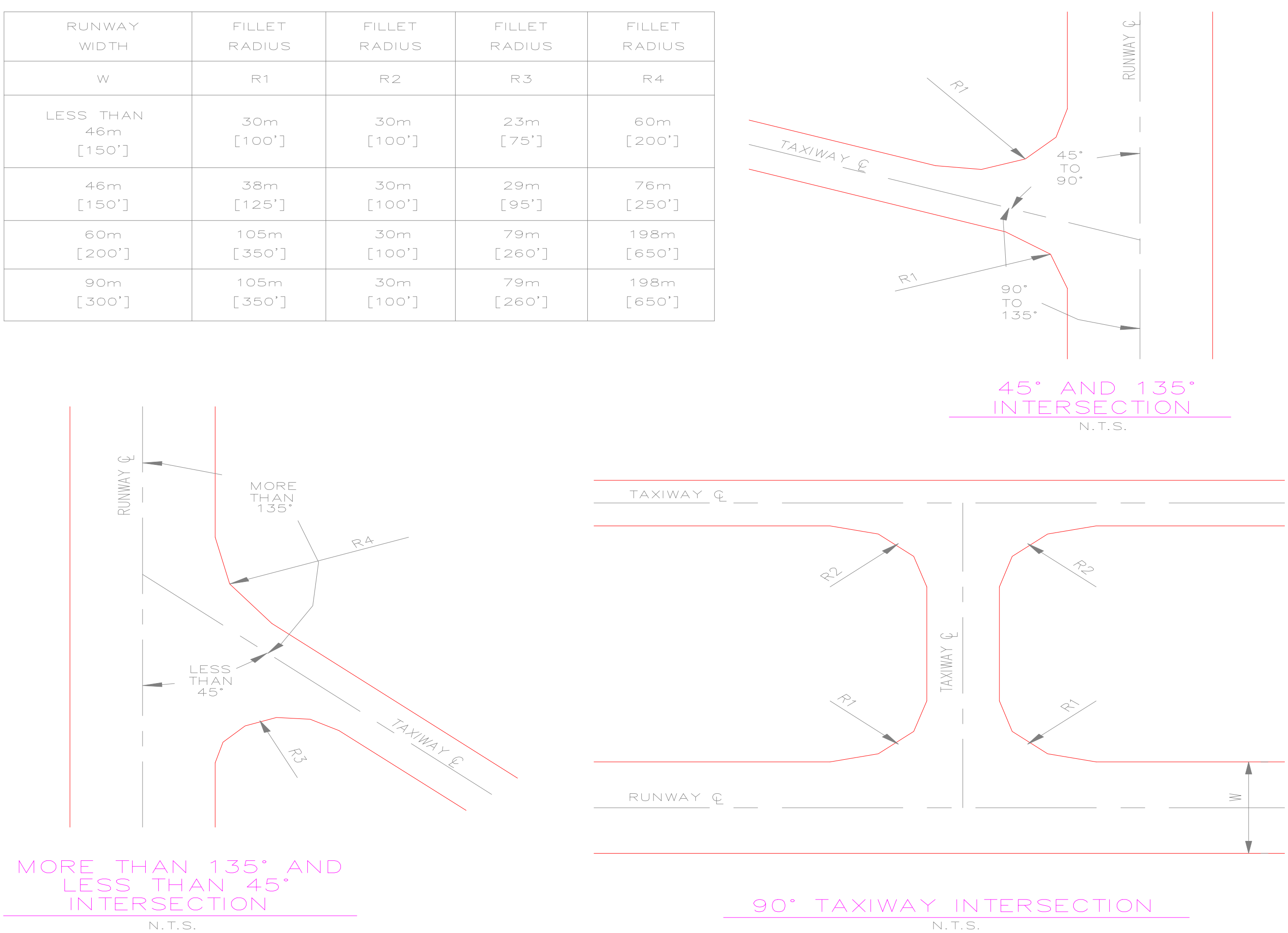
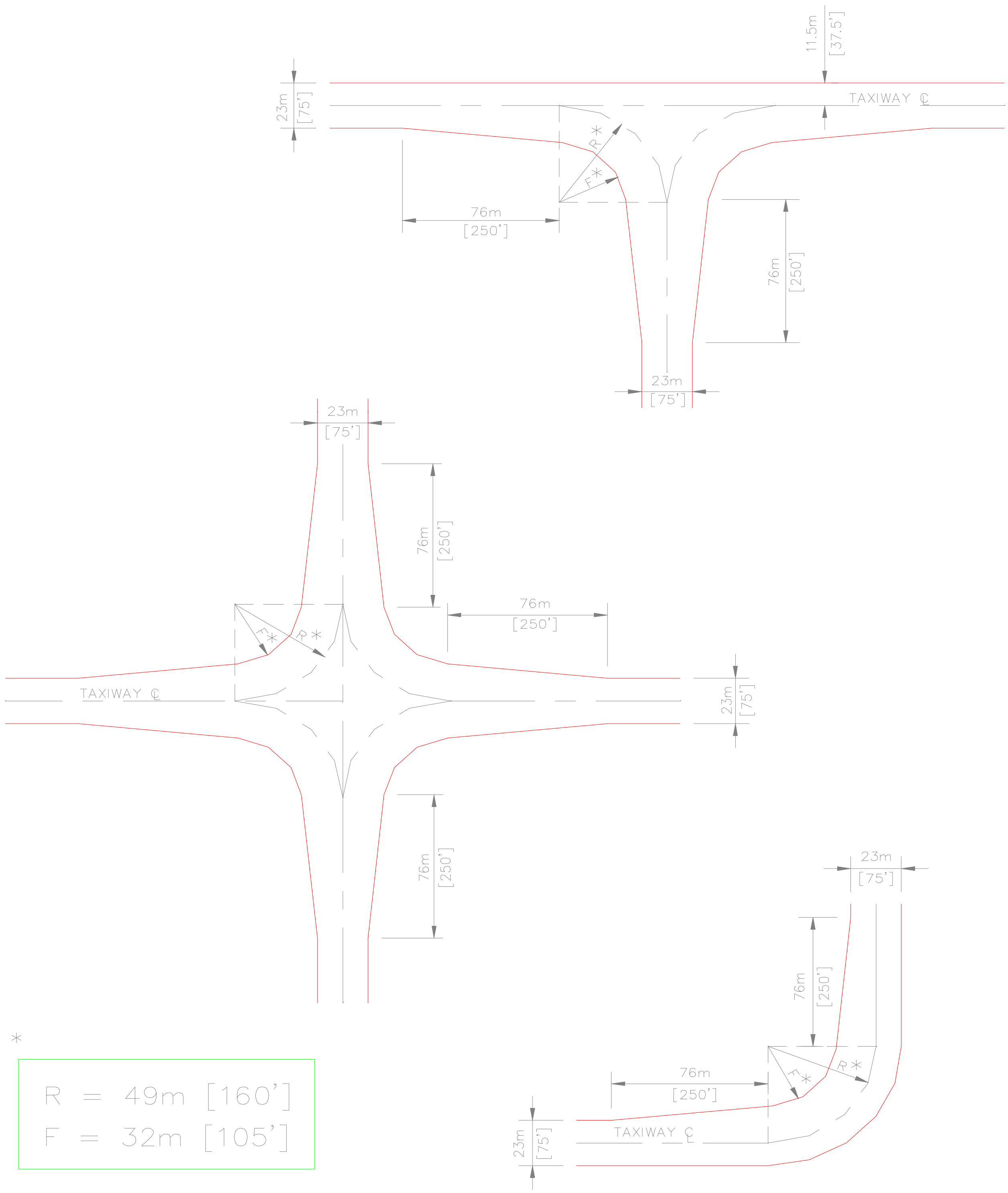


Figure 5.5. Intersection Geometry for Navy and Marine Corps Facilities Serving Aircraft with Wingspan Greater than 33.5 meters (110 feet).



5.12. Towways. A towway is used to tow aircraft from one location to another.

5.12.1. Dimensions. Table 5.4 presents the criteria for towway layout and design including clearances, slopes, and grading dimensions.

5.12.2. Layout. A typical transverse cross-section of a towway is shown in Figure 5.6.

5.12.3. Existing Roadway. When existing roads or other pavements are modified for use as towways, provide for necessary safety clearances, pavement strengthening (if required), and all other specific requirements set forth in Table 5.4 and Figure 5.6.

5.13. Hangar Access. The pavement which allows access from the apron to the hangar is referred to as a hangar access apron and is discussed in more detail in Chapter 6.

Table 5.4. Towways.

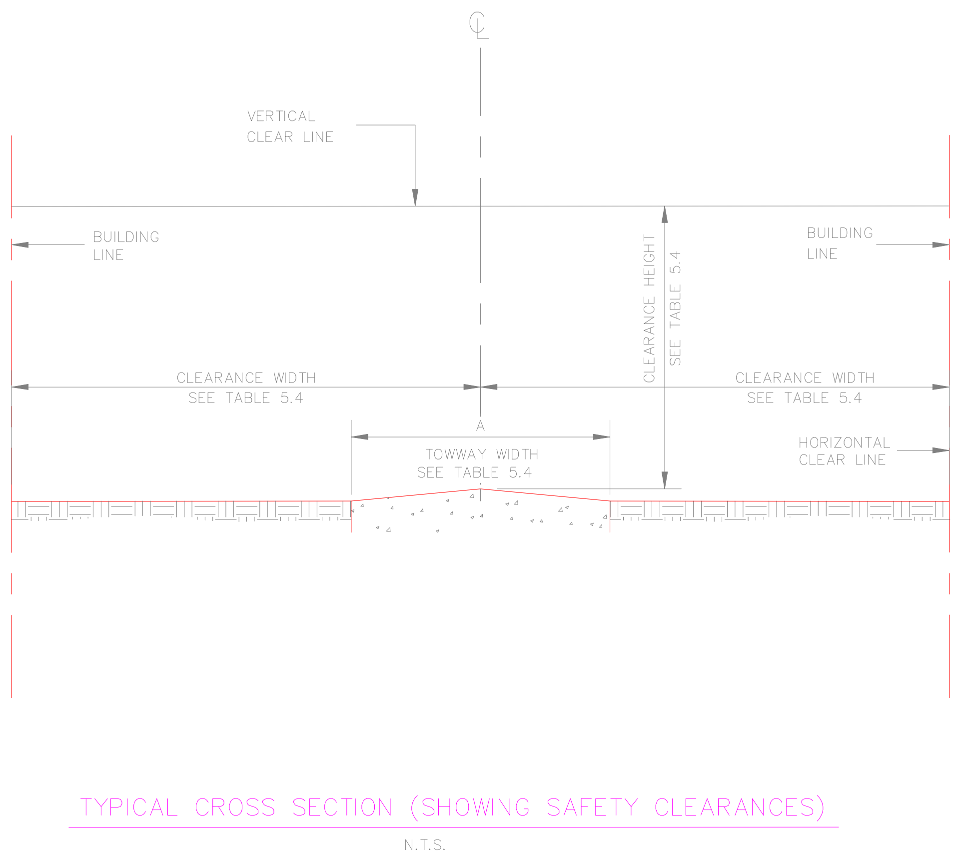
Item No.	Item Description	Class A Runway	Class B Runway	Remarks
		Requirement		
1	Width	(outside gear width of towed mission aircraft) +3 m [10 ft]		Army and Air Force facilities. 1.5 m [5 ft] on each side of gear.
		11 m [36 ft]		Navy and Marine Corps facilities for carrier aircraft.
		12 m [40 ft]		Navy and Marine Corps facilities for patrol and transport aircraft.
		10.7 m [35 ft]		Navy and Marine Corps facilities for rotary-wing aircraft.
2	Total Width of Shoulders (paved and unpaved)	7.5 m [25 ft]		
3	Paved Shoulder Width	Not Required		
4	Longitudinal Grade of Towway	Max 3.0%		Grades may be both positive and negative but must not exceed the limit specified.
5	Rate of Longitudinal Grade Change Per 30 m [100 ft]	Max 1.0%		The minimum distance between two successive points of intersection (PI) is 150 m [500 ft]. Changes are to be accomplished by means of vertical curves.
6	Longitudinal Sight Distance	NA (See note 1.)		
7	Transverse Grade	Min 2.0% Max 3.0%		Pavement crowned at towway centerline. Slope pavement downward from centerline of towway.

8	Towway Turning Radius	46 m [150 ft] radius	Criteria presented here are for straight sections of towway. Pavement width and horizontal clearance lines may need to be increased at horizontal curve locations, based on aircraft alignment on the horizontal curve.
9	Fillet Radius at Intersections	30 m [100 ft] radius	
10	Transverse Grade of Unpaved Shoulder	(a) 40 mm [1½"] drop off at edge of pavement. (b) 5% slope first 3 m [10 ft] from edge of pavement. (c) Beyond 3 m [10 ft] from edge of pavement, 2.0% min, 4.0% max.	
11	Horizontal Clearance From Towway Centerline to Fixed or Mobile Obstacles	The greater of: (½ the wing span width of the towed mission aircraft + 7.6 m [25 ft]); or the minimum of 18.25 m [60 ft]	Army and Air Force facilities.
		15 m [50 ft]	Navy and Marine Corps facilities for Carrier Aircraft.
		23 m [75 ft]	Navy and Marine Corps facilities for patrol and transport aircraft.
		14 m [45 ft]	Navy and Marine Corps facilities for rotary-wing aircraft.
12	Vertical Clearance From Towway Pavement Surface to Fixed or Mobile Obstacles	(Height of towed mission aircraft) + 3 m [10 ft]	Army and Air Force facilities.
		7.5 m [25 ft]	Navy and Marine Corps facilities for carrier aircraft.
		14 m [45 ft]	Navy and Marine Corps facilities for patrol and transport aircraft.
		9 m [30 ft]	Navy and Marine Corps facilities for rotary-wing aircraft
13	Grade (area between taxiway shoulder and taxiway clearance line)	Min of 2.0% prior to channelization Max 10%. (See note 2.)	

NOTES:
1. NA = Not Applicable
2. Bed of channel may be flat.

3. Metric units apply to new airfield construction and where practical modification to existing airfields and heliports, as discussed in paragraph 1.4.4.
4. The criteria in this manual are based on aircraft specific requirements and are not direct conversions from inch-pound (English) dimensions. Inch-pound units are included only as a reference to the previous standard.
5. Airfield and heliport imaginary surfaces and safe wingtip clearance dimensions are shown as a direct conversion from inch-pound to SI units.

Figure 5.6. Towway Criteria.



Chapter 6

APRONS AND OTHER PAVEMENTS

6.1. Contents. This chapter presents design standards for fixed and rotary-wing aircraft parking aprons, access aprons, maintenance pads, and wash racks. It provides minimum wing-tip clearance requirements, grades, and lateral clearance standards, as well as typical aircraft parking arrangements. The general principals of this chapter apply to the US Navy and Marine Corps. Specific data for Navy and Marine Corps aprons is contained in the referenced publications.

6.2. Apron Requirements. Aprons must provide sufficient space for parking fixed- and rotary-wing aircraft. They should be sized to allow safe movement of aircraft under their own power. Consider the effects of jet blast turbulence and temperature during design. Programming requirements for Air Force aviation facilities are found in AFH 32-1084, *Standard Facility Requirements Handbook*. Requirements for Navy and Marine Corps aviation facilities are contained in NAVFAC P-80 and MIL-HDBK-1021/1, *General Concepts for Airfield Pavement Design*. The general principles of this chapter apply to the Navy and the Marine Corps. Specific data on Navy/Marine Corps aprons is contained in the referenced publications.

6.3. Types of Aprons and Other Pavements. The following is a list of aprons and other aviation facilities:

6.3.1. Aircraft parking apron.

6.3.2. Transient parking apron.

6.3.3. Mobilization apron.

6.3.4. Aircraft maintenance apron.

6.3.5. Hangar access apron.

6.3.6. Warm-up pad (holding apron).

6.3.7. Unsuppressed power check pads.

6.3.8. Arm/disarm pad.

6.3.9. Compass calibration pad.

6.3.10. Hazardous cargo pad.

6.3.11. Alert pad.

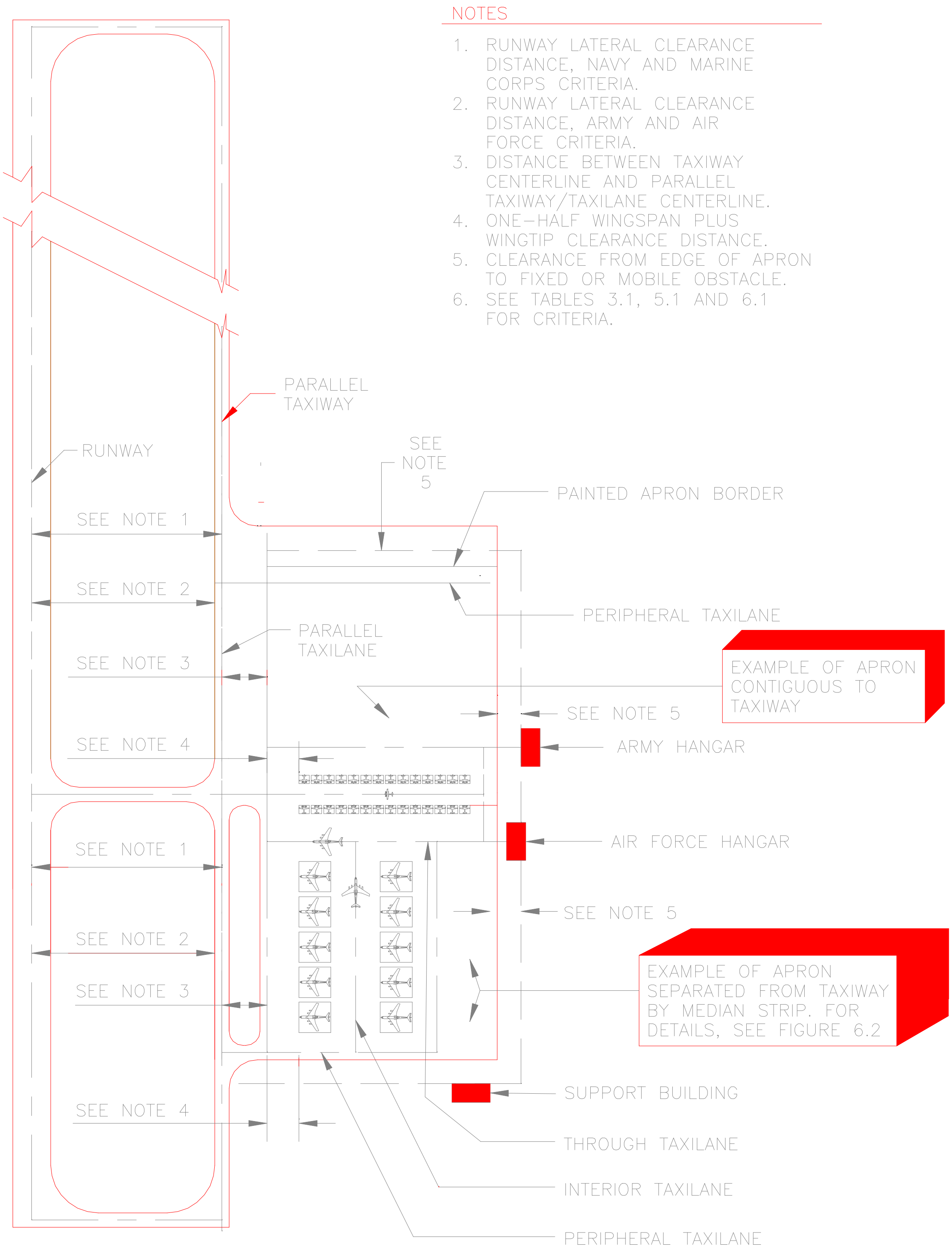
6.3.12. Aircraft wash rack.

6.4. Aircraft Characteristics. Dimensional characteristics of various military, civil, and commercial fixed- and rotary-wing aircraft are available in U.S. Army Engineering Technical Letter 1110-3-394, *Aircraft Characteristics for Airfield-Heliport Design and Evaluation*.

6.5. Parking Apron for Fixed-Wing Aircraft. Fixed-wing parking at an aviation facility may consist of separate aprons for parking operational aircraft, transient aircraft and transport aircraft, or an apron for consolidated parking.

6.5.1. Location. Parking aprons should be located near and contiguous to maintenance and hangar facilities. Do not locate them within runway and taxiway lateral clearance distances. A typical parking apron is illustrated in Figure 6.1.

Figure 6.1. Apron Nomenclature and Criteria.



6.5.2. Size. As a general rule, there are no standard sizes for aircraft aprons. Aprons are individually designed to support aircraft and missions at specific facilities. The actual dimensions of an apron are based on the number of authorized aircraft, maneuvering space, and type of activity the apron serves. Air Force allowances are provided in AFH 32-1084, *Standard Facility Requirements*

Handbook. Army facility authorizations are discussed in Attachment 3 and the individual service components programming directive. The ideal apron size affords the maximum parking capacity with a minimum amount of paving. Generally, this is achieved by reducing the area dedicated for use as taxilanes by parking aircraft perpendicular to the long axis of the apron.

6.5.3. Army Parking Apron Layout:

6.5.3.1. Variety of Aircraft. Where there is a large variety of fixed-wing aircraft types, fixed-wing aircraft mass parking apron dimensions will be based upon the C-12J (Huron). The C-12J parking space width is 17 meters [55 feet] and the parking space length is 18.25 meters [60 feet].

6.5.3.2. Specific Aircraft. If the assigned aircraft are predominantly one type, the mass parking apron will be based on the specific dimensions of that aircraft.

6.5.3.3. Layout. Figure 6.2 illustrates a parking apron. These dimensions can be tailored for specific aircraft, including the C-12J (Huron).

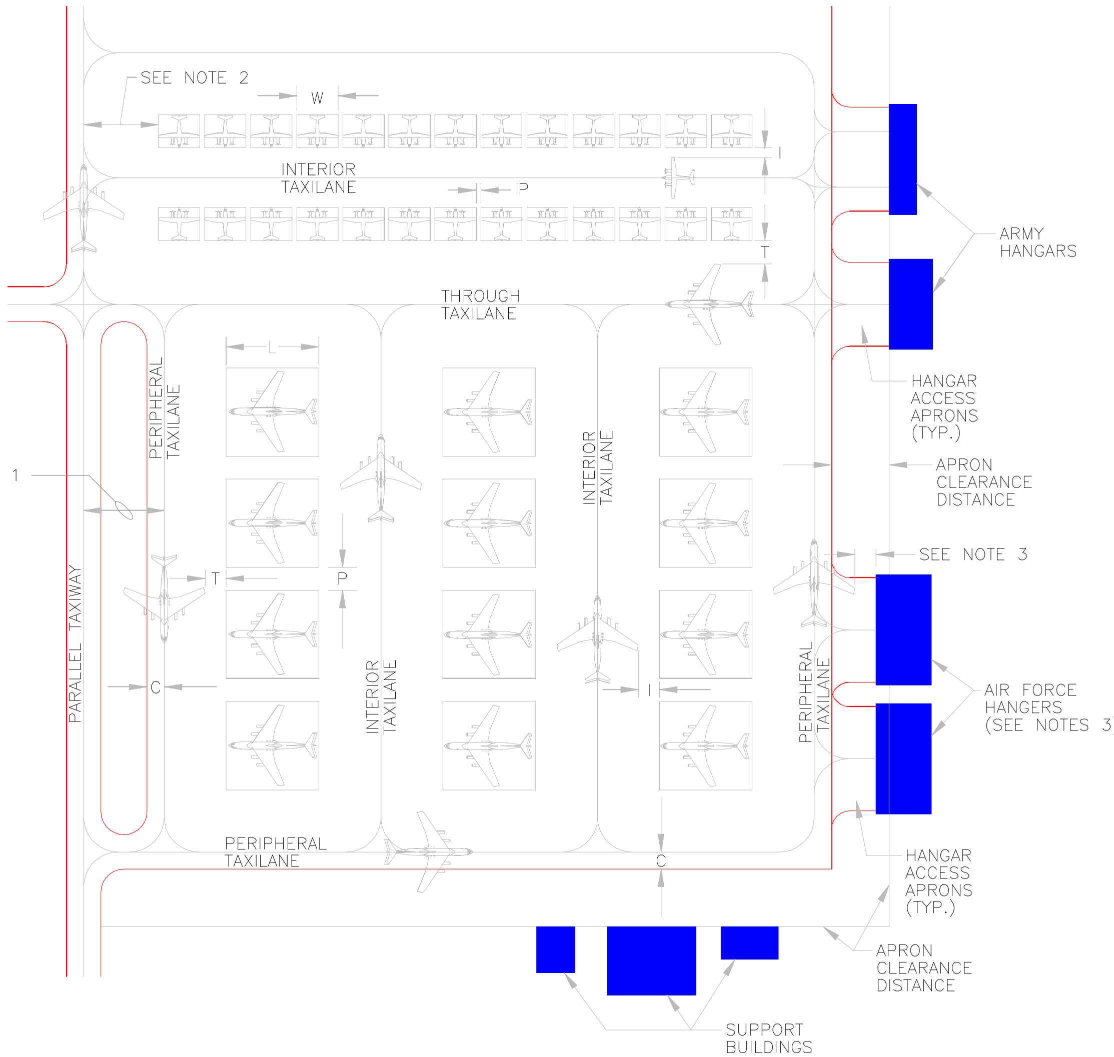
6.5.4. Air Force Parking Apron Layout. Parking apron dimensions for Air Force facilities will be based on the specific aircraft assigned to the facility and the criteria presented in AFH 32-1084, Standard Facility Requirements Handbook. A typical mass parking apron should be arranged in rows as shown in Figure 6.2.

6.5.5. Layout for Combined Army and Air Force Parking Aprons. Parking apron dimensions for combined Army and Air Force facilities will be based on the largest aircraft assigned to the facility.

6.5.6. Tactical/Fighter Parking Apron Layout. The recommended tactical/fighter aircraft parking arrangement is to park aircraft at a 45-degree (45°) angle as discussed in AFH 32-1084. Arranging these aircraft at a 45-degree angle is the most economical method for achieving the clearance needed to dissipate jet blast temperatures and velocities to levels that will not endanger aircraft or personnel. Jet blast relationships for tactical and fighter aircraft are discussed in Army ETL 1110-3-394.

6.5.7. Refueling Considerations. Layout of aircraft parking locations and taxilanes should consider aircraft taxiing routes when an aircraft is refueled. Refueling operations should not prevent an aircraft from leaving the parking apron. Two routes in and out of the apron may be required. During refueling, active ignition sources such as sparks from ground support equipment or jet engines (aircraft) are prohibited from a zone around the aircraft. The Army and Air Force refer to this zone as the Fuel Servicing Safety Zone (FSSZ). The Navy and Marine Corps refer to this zone as the Refueling Safety Zone (RSZ). An example of the refueling safety zone around a fixed-wing aircraft is shown in Figure 6.3. The safety zone is the area within 15 meters [50 feet] of a pressurized fuel carrying servicing component; e.g., servicing hose, fuel nozzle, single-point receptacle (SPR), hydrant hose car, ramp hydrant connection point, and 7.6 meters [25 feet] around aircraft fuel vent outlets. The fuel servicing safety zone is established and maintained during pressurization and movement of fuel. For additional information, see Air Force T.O. 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding.* For Navy, also see MIL-HDBK-274, *Electrical Grounding for Aircraft Safety*.

Figure 6.2. Army and Air Force Parking Plan.



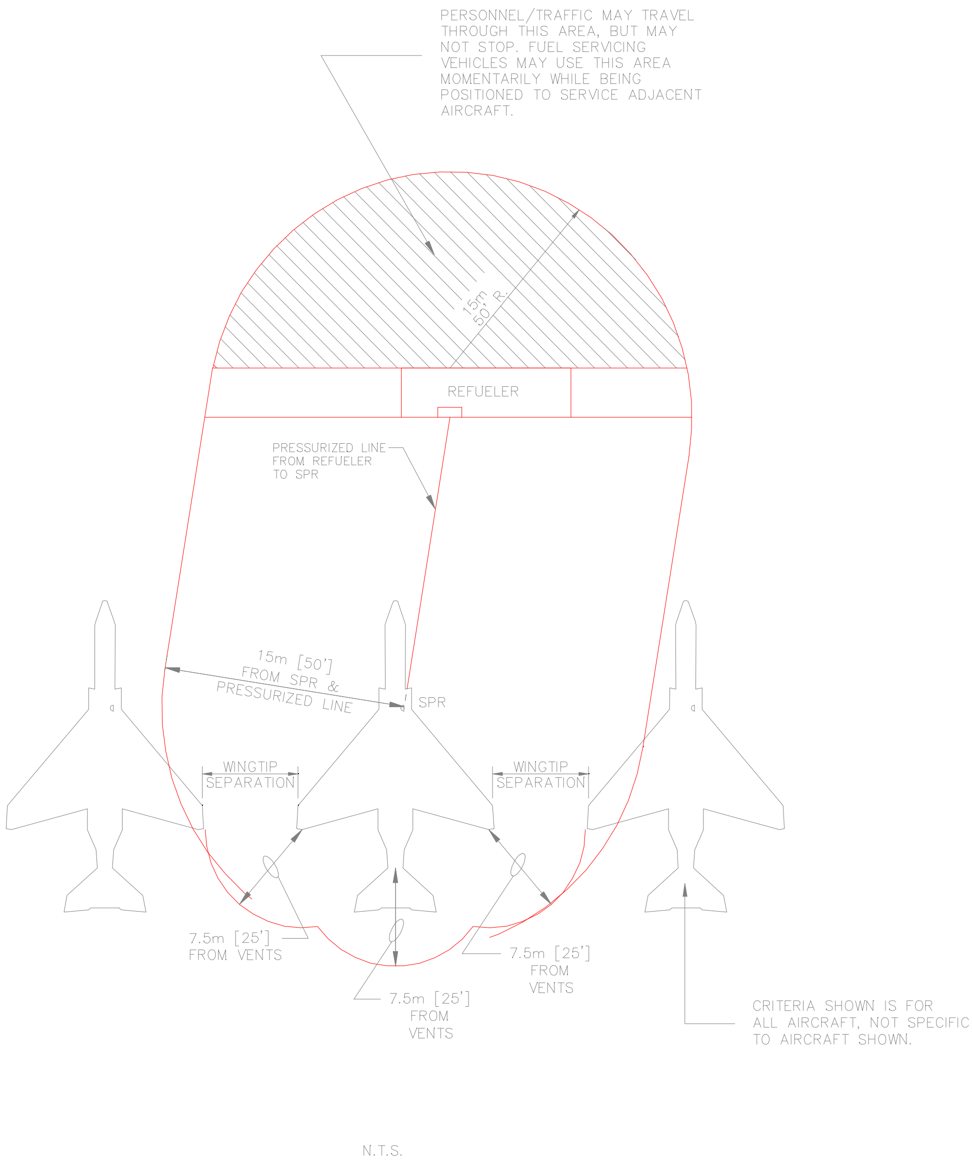
LEGEND

W --- AIRCRAFT WIDTH
L --- AIRCRAFT LENGTH
I --- WINGTIP CLEARANCE FOR INTERIOR TAXILINE (MIN. TAXI CLEARANCE)
T --- WINGTIP CLEARANCE FOR THROUGH AND PERIPHERAL TAXILINES
P --- WINGTIP CLEARANCE FOR PARKED AIRCRAFT
C --- DISTANCE FROM PERIPHERAL TAXILANE CENTERLINE TO THE APRON EDGE

NOTES

1. TAXIWAY CLEARANCE DISTANCE AT FACILITIES WITH PARALLEL TAXIWAYS; SEE TABLE 5.1, ITEM 11.
2. SEE TABLE 6.1 FOR DIMENSIONAL DEFINITIONS.
3. FOR AIR FORCE: INSURE MINIMUM WINGTIP CLEARANCE IS PROVIDED TO HANGARS OR OTHER PERMISSIBLE DEVIATIONS (SEE TABLE 6.1 ITEM 15 AND ATTACHMENT 14)

Figure 6.3. Truck Refueling Safety Zone Example.



6.5.8. Parking Dimensions. Table 6.1 presents minimum geometric criteria for fixed-wing apron design. When designing new aprons for Air Mobility Command bases hosting C-5, C-17, KC-10, and KC-135 aircraft, provide 15.3 meter (50 foot) wingtip separation. EXCEPTION: When you are rehabilitating an existing apron, provide the maximum wingtip separation the existing apron size will allow (up to 15.3 meters (50 feet), but not less than 7.7 meters (25 feet). This additional separation is both desirable and permitted. At non-AMC bases, the maximum separation which can reasonably be provided for these aircraft is desirable.

6.5.8.1. Jet Blast Considerations. The clearances listed in Table 6.1 do not consider the effects of temperature and velocity due to jet blast. The effects of jet blast are described in Attachment 8.

6.5.8.2. Cargo Loading Considerations. Consider the effects of jet blast on aircraft loading operations and cargo storage locations when you design a layout for parking cargo aircraft.

Table 6.1. Fixed-Wing Aprons.

Item No.	Item Description	Class A Runway	Class B Runway	Remarks
		Requirement		
1	Size and Configuration	Variable For Army and Air Force requirements, see criteria listed below and AFH 32-1084. For Navy and Marine Corps requirements, see Navy NAVFAC P-80.		As a general rule there are no standard sizes for aprons. They are individually designed to support specific aircraft uses. The dimensions are determined by the number and type of aircraft involved, the function of the apron, the maneuvering characteristics of the aircraft, jet blast of the aircraft, and the degree of unit integrity to be maintained. Other determinants are the physical characteristics of the site, relationship of the apron area to other airfield facilities and the objective of the comprehensive plan.
2	Parking Space Width ("W")	Design aircraft wingspan		Army and Air Force airfields.
3	Parking Space Length ("L")	Design aircraft length		Army and Air Force airfields.
4	Wingtip Clearance of Parked Aircraft ("P")	3.1 m [10 ft]		Army and Air Force airfields, aircraft with wingspans up to 33.5 m [110 ft].
		6.1 m [20 ft]		Army and Air Force airfields, aircraft with wingspans of 33.5 m (110 ft) or more except as noted below. See Note 1.
		7.7 m [25 ft]		Army and Air Force airfields, transient aprons, C-5 and C-17 aircraft (also see paragraph 6.5.8). See Note 1.
		15.3 m [50 ft]		Army and Air Force airfields, KC-10 and KC-135 aircraft to accommodate fuel load changes. See Note 1.

5	Wingtip Clearance of Aircraft on Interior Taxilanes (“I”)	6.1 m [20 ft]	Army and Air Force airfields, aircraft with wingspans up to 33.5 m (110 ft), except transient aprons. See Note 1.
		7.7 m [25 ft]	Army and Air Force airfields, transient aprons. See Note 1.
		9.2 m [30 ft]	Army and Air Force airfields, aircraft with wingspans of 33.5 m [110 ft] or more. See Note 1.
6	Wingtip Clearance of Aircraft on Through or Peripheral Taxilanes (“T”)	9.2 m [30 ft]	Army and Air Force airfields, aircraft with wingspans up to 33.5 m (110 ft). See Note 1.
		Min 15.3 m [50 ft]	Army and Air Force airfields, aircraft with wingspans of 33.5 m [110 ft] or more. See Note 1.
7	Distance from Peripheral Taxilane Centerline to the Apron Edge ("C")	7.7 m [25 ft]	Army and Air Force airfields. Designed for aircraft with wingspan up to 33.5 m [110 ft].
		11.5 m [37.5 ft]	Army and Air Force airfields. Designed for aircraft with wingspan of 33.5 m [110 ft] and greater.
8	Clear Distance Around Aircraft During Fueling (FSSZ) (RSZ)	7.7 m [25 ft]	Around aircraft fuel vent outlets (see T.O. 00-25-172).
		15.3 m [50 ft]	From a pressurized fuel carrying servicing component (see T.O. 00-25-172).
		See Remarks	Consider refueling operations when locating taxilanes.
9	Grades in the Direction of Drainage	Min 0.5% Max 1.5%	Avoid surface drainage patterns with numerous or abrupt grade changes. This can produce excessive flexing of aircraft and structural damage.

10	Width of Shoulders (Total Width Including Paved and Unpaved)	7.5 m [25 ft]	15 m [50 ft]	For Army and Air Force airfields.
11	Paved Width of Shoulders	7.5 m [25 ft]	7.5 m [25 ft]	Army and Air Force airfields not otherwise specified.
		Not Applicable	15 m [50 ft]	Army and Air Force airfields that accom-modate B-52, C-5, E-4 and 747 aircraft.
12	Longitudinal Grade of Shoulders	Variable		Conform to longitudinal grade of the abutting primary pavement.
13	Transverse Grade of Paved Shoulder	Min 2.0% Max 4.0%		Army airfields and Air Force airfields not otherwise specified.
		NA	Min 1.5% Max 2.0%	Air Force airfields that accommodate B-52 aircraft.
14	Transverse Grade of Unpaved Shoulders	NA	(a) 40 mm [1-½"] drop off at edge of paved shoulder. (b) 5% slope first 3 m [10 ft] from paved shoulder. (c) Beyond 3 m [10 ft] from edge of paved shoulder, 2.0% min, 4.0% max.	
15	Clearance from Apron Boundary Marking to Fixed or Mobile Obstacles	30 m [100 ft]	40 m [125 ft]	Army airfields. This distance to be clear of all fixed and mobile obstacles.
		38.1 m [125 ft]		Air Force airfields. This distance to be clear of all fixed and mobile obstacles except as noted in Attachment 14. **Note: If light poles are within this distance, additional operational requirements may apply.**

16	Grades in Cleared Area Beyond Shoulders to Fixed or Mobile Obstacles	(a) 40 mm [1-½"] drop off at edge of paved shoulder. (b) 5% slope first 3 m [10 ft] from paved shoulder. (c) Beyond 3 m [10 ft] from the edge of the paved shoulder, 10%.	Max 10.0%	

Notes:

1. Wingtip clearances may be reduced to those allowed by AFI 11-218, Aircraft Operation and *Movement on the Ground*, with a waiver.
2. Metric units apply to new airfield construction, and where practical modifications to existing airfields and heliports, as discussed in Paragraph 1.4.4.
3. The criteria in this manual are based on aircraft specific requirements and are not direct conversions from inch-pound (English) dimensions. Inch-pound units are included only as a reference to the previous standard.
4. Airfield and heliport imaginary surfaces and safe wingtip clearance dimensions are shown as a direct conversion from inch-pound to SI units.

6.6. Taxiing Characteristics on Aprons for Fixed-Wing Aircraft:

6.6.1. Apron Taxilanes. Taxi routes across parking aprons, referred to as taxilanes, are marked on the apron for safe passage of the aircraft. Typical taxilane locations are illustrated in Figures 6.1 and 6.4. Minimum wingtip clearances between parked and taxiing aircraft are shown in Table 6.1. (See Figure 6.2.) AFI 11-218 provides authorization for operation of aircraft at reduced clearances under certain circumstances. If a decision is made to reduce clearances based upon this authorization, you must waive the safe clearance requirements provided within this chapter in accordance with Attachment 2.

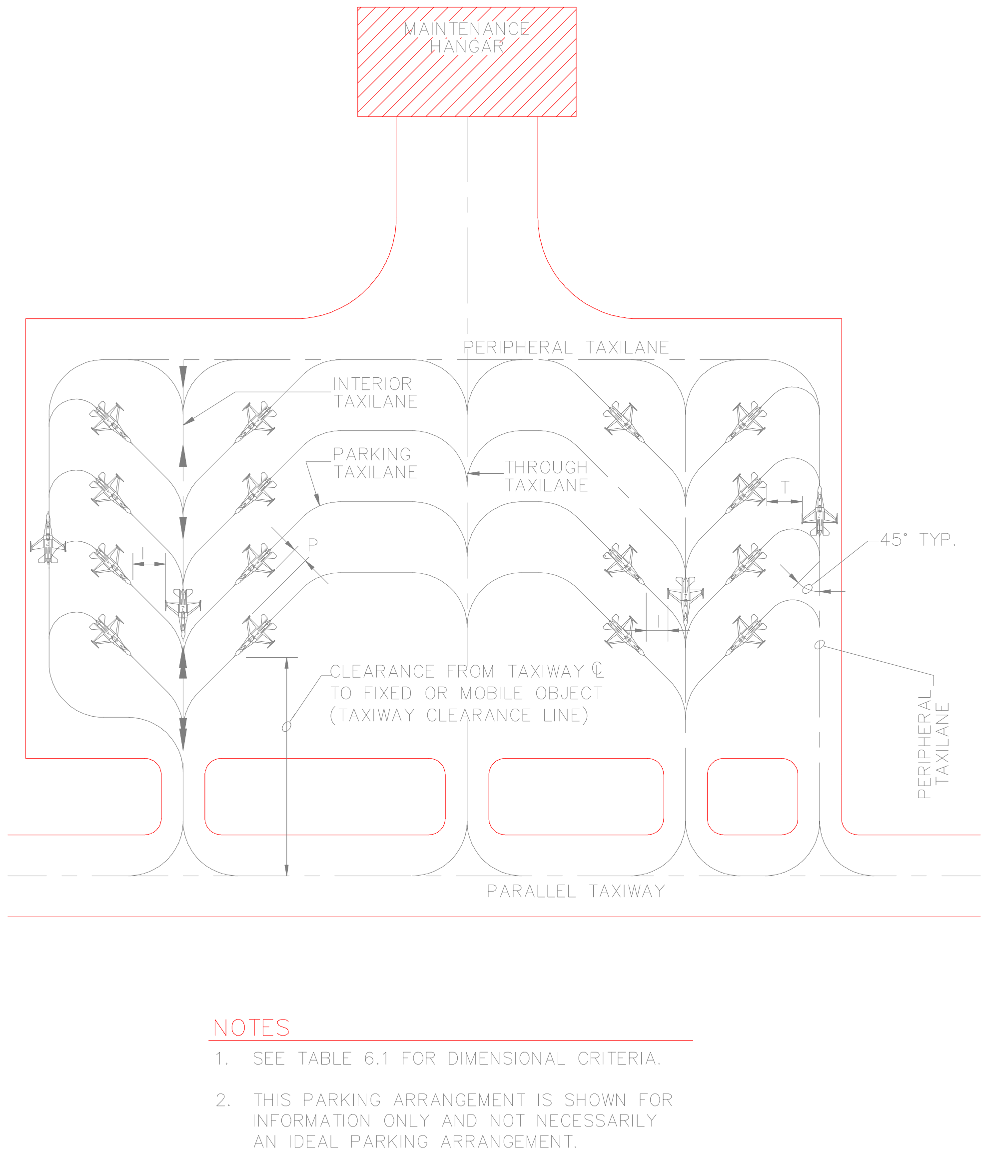
6.6.2. Turning Capabilities (Aircraft Turning and Maneuvering Characteristics). Army ETL 1110-3-394, *Aircraft Characteristics for Airfield-Heliport Design and Evaluation*, provides sources for obtaining various turning diagrams for U.S. Army, Air Force, and numerous civil and commercial fixed wing aircraft.

6.6.3. Departure Sequencing. Egress patterns from aircraft parking positions to taxiways should be established to prevent congestion at the apron exits.

6.7. Parking Apron for Rotary-Wing Aircraft. Mass parking of rotary-wing aircraft will require an apron designated for rotary-wing aircraft. Parking for transient rotary-wing aircraft and at aviation facilities where only a few rotary-wing aircraft are assigned, may be located on aprons for fixed-wing aircraft. At aviation facilities with assigned rotary-wing aircraft, a transport apron for fixed-wing aircraft is desirable.

6.7.1. Location. Parking aprons for rotary-wing aircraft should be located similar to parking aprons for fixed-wing aircraft. Rotary-wing aprons must not be located within the Lateral Clearance Distances discussed in Chapters 3 and 4 of this manual. Generally, company and/or squadron units should be parked together in rows for organizational integrity in locations adjacent to their assigned hangars. Parking aprons for small helicopters (OH, UH and AH) should be separate from parking areas used by cargo helicopters due to the critical operating characteristics of the larger aircraft.

Figure 6.4. Apron With Diagonal Parking.



6.7.2. Apron Size. As with fixed-wing aircraft aprons, there is no standard size for rotary-wing aircraft aprons. The actual dimensions are based on the number of authorized aircraft, maneuvering space and type of activity the apron serves. Aircraft authorization is discussed in Attachment 3.

6.7.3. Maneuverability. The layout of the rotary-wing parking spacings should allow aircraft access to these locations.

6.7.3.1. Approach. Rotary-wing aircraft approach the parking spaces with either a front approach or a sideways approach.

6.7.3.2. Undercarriage. Rotary-wing aircraft are equipped with either a skid gear or wheel gear. Once on the ground, skid gear equipped helicopters cannot be easily moved. Wheeled rotary-wing aircraft can be moved once they are on the ground.

6.7.4. Army Parking Apron Layout. Rotary-wing aircraft are parked in one of two configurations referred to as Type 1 or Type 2.

6.7.4.1. Type 1. In this configuration, rotary-wing aircraft are parked in a single lane, which is perpendicular to the taxilane. When parked in this configuration, the parking arrangement resembles that of fixed-wing aircraft. This parking arrangement is preferred for wheeled aircraft.

6.7.4.1.1. Parking Space, All Aircraft Except CH-47. The parking space dimensions for all rotary-wing aircraft except the CH-47, in the Type 1 configuration, is a width of 25 meters [80 feet] and a length of 30 meters [100 feet]. This is illustrated in Figure 6.5.

6.7.4.1.2. Parking Space - CH-47. The parking space dimensions for the CH-47 rotary-wing aircraft, in the Type 1 configuration is a width of 30 meters [100 feet] and a length of 46 meters [150 feet]. This is illustrated in Figure 6.6.

6.7.4.2. Type 2. In this configuration, rotary-wing aircraft are parked in a double lane, which is parallel to the taxilane. This parking arrangement is preferred for skid-gear aircraft.

6.7.4.2.1. Parking Space, Skid-Gear Aircraft. The parking space dimensions for all skid-gear rotary-wing aircraft in the Type 2 configuration is a width of 25 meters [80 feet] and a length of 30 meters [100 feet]. This is illustrated in Figure 6.7.

6.7.4.2.2. Parking Space, Wheeled. The parking space dimensions for all wheeled rotary-wing aircraft, in the Type 2 configuration is a width of 30 meters [100 feet] and a length of 50 meters [160 feet]. This is illustrated in Figure 6.8.

6.7.5. Air Force Parking Apron Layout. Rotary-wing aircraft at Air Force facilities are parked in a layout similar to fixed-wing aircraft. Parking space, taxilane, and clearance dimensions for Air Force facilities will be based on the rotor diameter of the specific aircraft assigned to the facility. See AFH 32-1084, table 2.7.

6.7.6. Refueling Considerations. As discussed in paragraph 6.6.8, layout of aircraft parking locations and taxilanes should consider aircraft taxiing routes when an aircraft is refueled. The safety zone for rotary-wing aircraft is the area 3 meters [10 feet] greater than the area bounded by the blades and tail of the aircraft. For additional information, see Air Force T.O. 00-25-172.

6.7.7. Parking Dimensions. Table 6.2 presents the criteria for rotary-wing apron design for Army airfields. Included in this table are parking space widths, grade requirements and clearances. Criteria for rotary-wing apron design for the Air Force are presented in AFH 32-1084 and for the Navy in NAVFAC P-80. USAF activities may use Army criteria presented in this manual or the criteria given in AFH 32-1084.

Figure 6.5. Type 1 Parking for All Rotary Wing Aircraft Except CH-47.

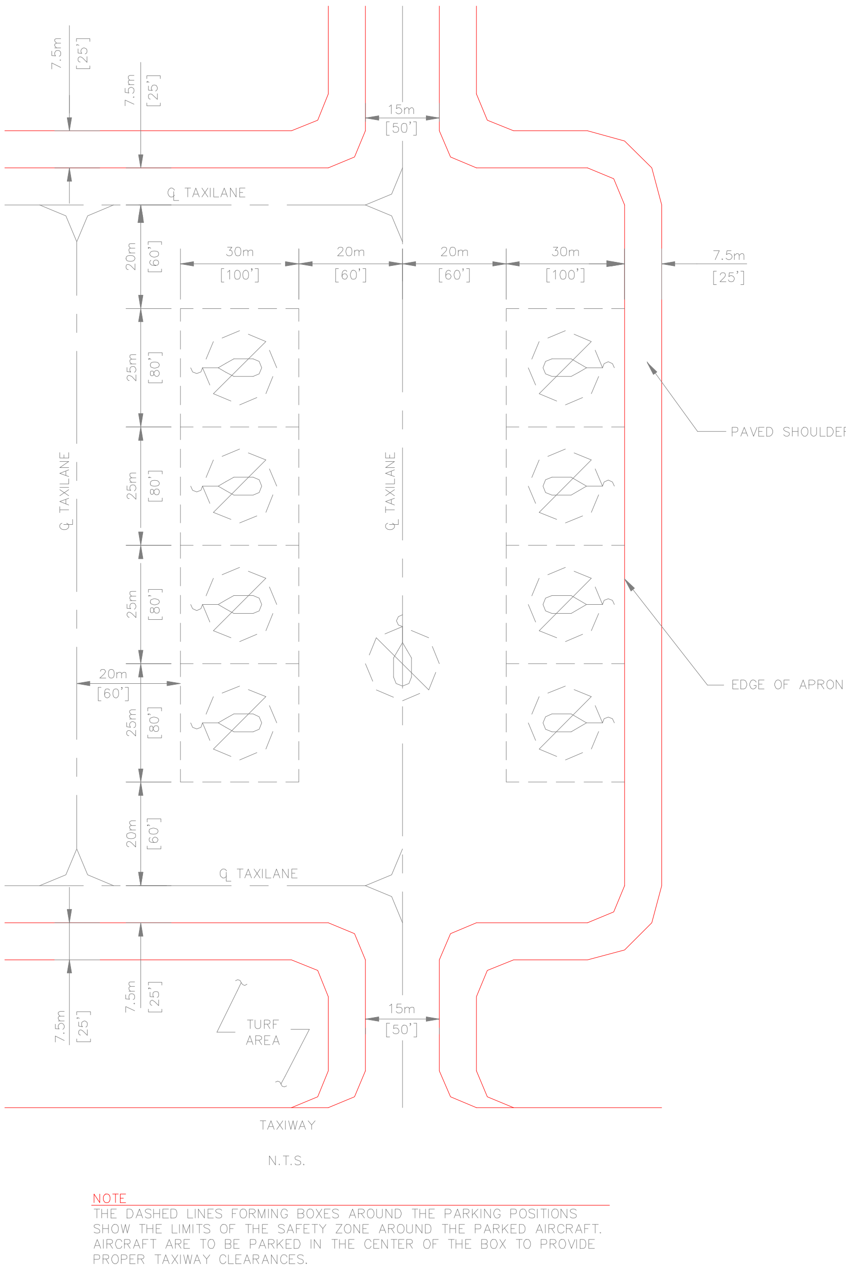


Figure 6.6. Type 1 Parking for CH-47.

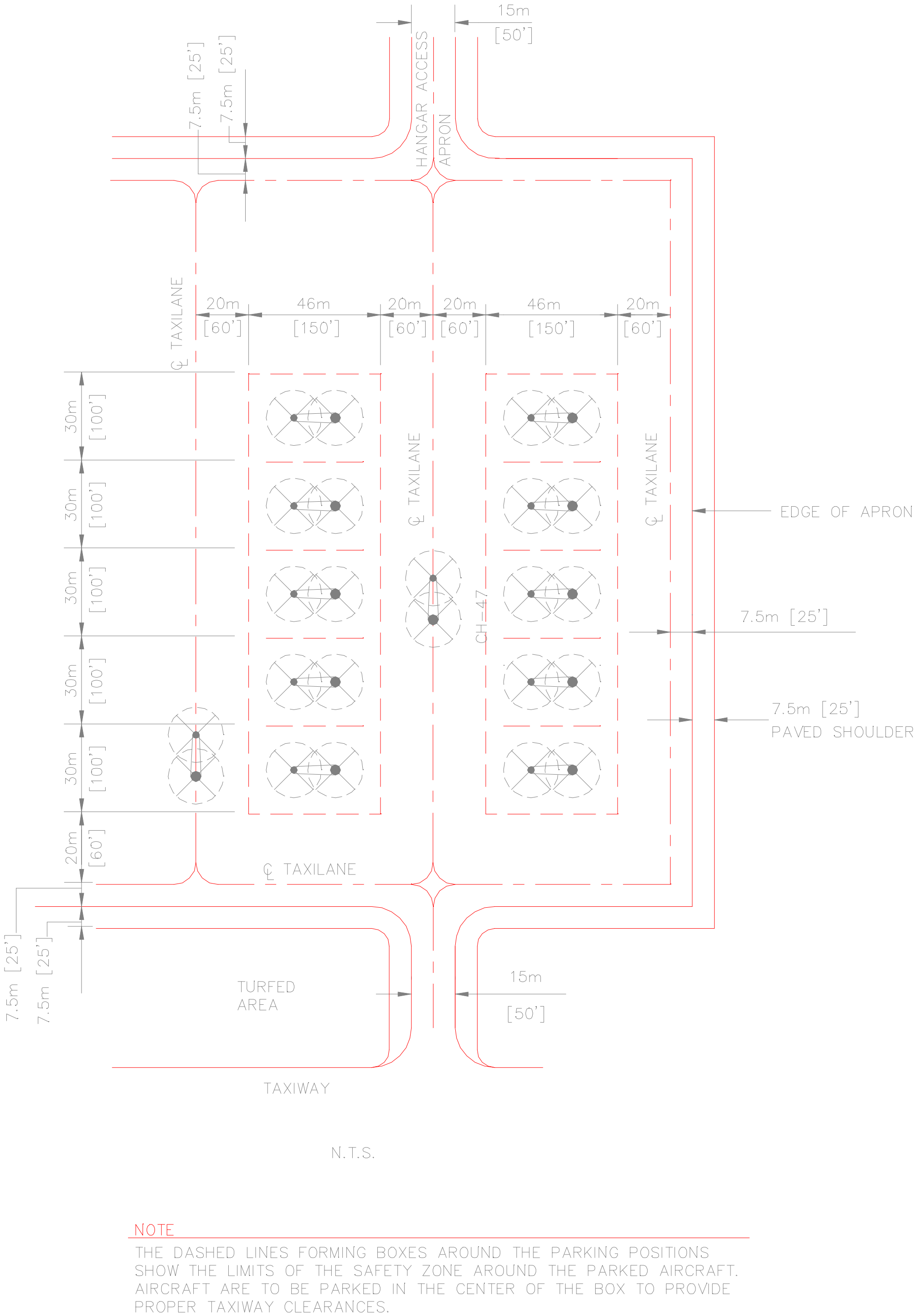


Figure 6.7. Type 2 Parking for Skid Rotary Wing Aircraft.

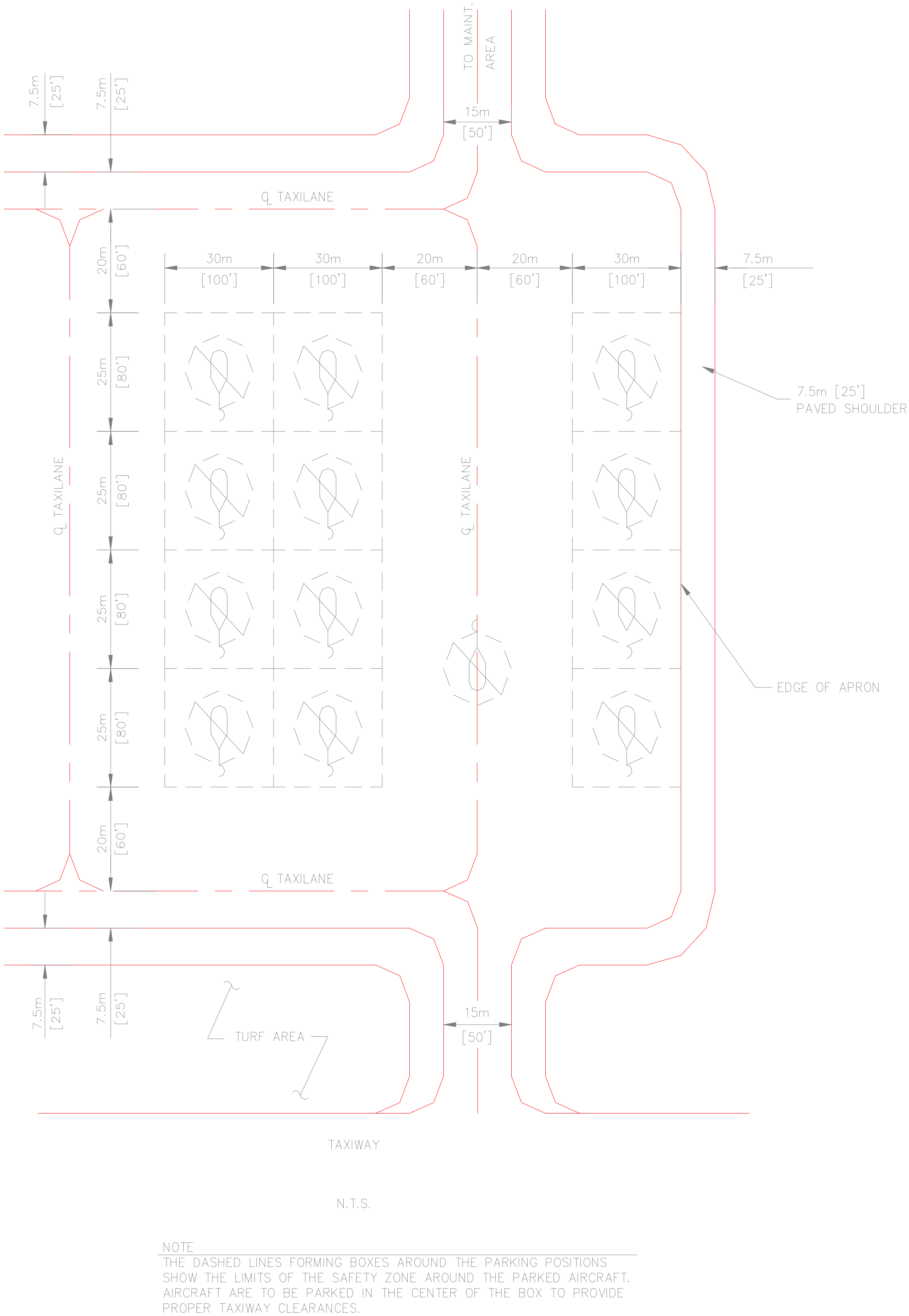
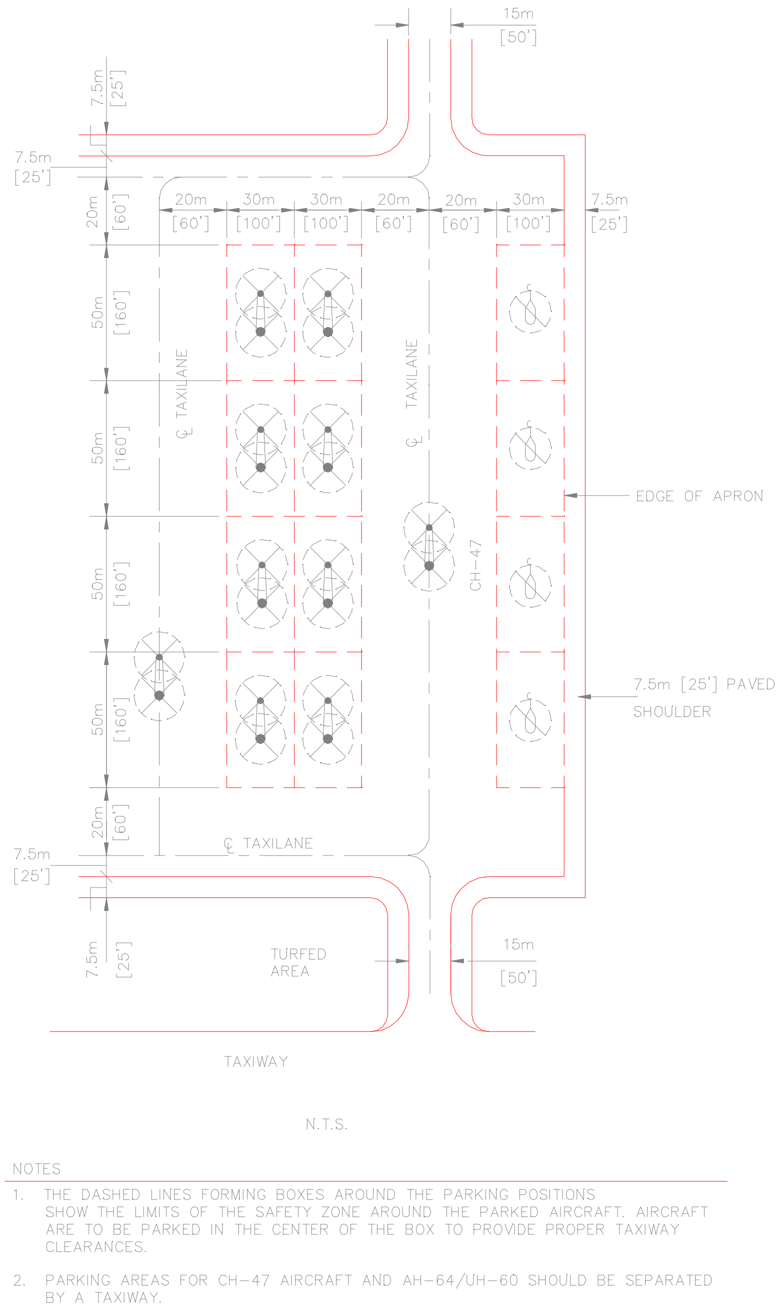


Figure 6.8. Type 2 Parking for Wheeled Rotary Wing Aircraft.



6.7.7.1. Distances Between Parking Spaces. The parking space dimensions, discussed in Table 6.2, include separation distances between parked aircraft. When laying out the rotary-wing parking spaces, the spaces should abut next to each other. Separation between rotors and the aircraft bodies are also included in the parking space dimension.

6.7.7.2. Rotor Blade Clearances. Taxilane and hoverlane dimensions provided in Table 6.2 provide adequate rotor blade clearances for the size of helicopter noted.

Table 6.2. Rotary-Wing Aprons for Army Airfields.

Item No.	Item Description	Requirement	Remarks
1	Size and Configuration	Variable For Air Force space requirements, see AFH 32-1084. For Navy and Marine Corps space requirements, see NAVFAC P-80.	Aprons are determined by the types and quantities of helicopters to be accommodated. Other determinants are the physical characteristics of the site and the objective of the master plan.
2	Type 1 Parking Space Width	25 m [80 ft]	Army helicopters not otherwise specified.
		30 m [100 ft]	Army CH-47 helicopters.
			Helicopters parked in single lanes and perpendicular to the taxilane. Park helicopter in center of parking space.
3	Type 1 Parking Space Length	30 m [100 ft]	Army helicopters not otherwise specified.
		46 m [150 ft]	Army CH-47 helicopters.
			Helicopters parked in a single lane and perpendicular to the taxilane. Park helicopter in center of parking space.
4	Type 2 Parking Space Width	25 m [80 ft]	Army helicopters, skid configuration.
		30 m [100 ft]	Army helicopters, wheeled configuration.
			Helicopter parked in double lanes and parallel to the taxilane. Park helicopter in center of parking space.
5	Type 2 Parking Space Length	30 m [100 ft]	Army helicopters with skid configuration.
		50 m [160 ft]	Army helicopters with wheeled configuration.
			Helicopter parked in double lanes and parallel to the taxilane. Park helicopter in center of parking space.

6	Distance Between Edge of Parking Space and Taxilane Centerline	20 m [60 ft]	All Army helicopters.
7	Grades in the direction of drainage	Min 0.5% Max 1.5%	Engineering analysis occasionally may indicate a need to vary these limits. However, arbitrary deviation is not intended. Avoid surface drain-age with numerous or abrupt grade changes that can cause adverse flexing in the rotor blades.
8	Interior Taxilane/ Hoverlane Width (Between Rows of Aircraft)	40 m [120 ft]	From edge of parking space to edge of parking space.
9	Peripheral Taxilane/ Hoverlane Width	26 m [85 ft]	From edge of parking space to edge of apron.
10	Distance Between Peripheral Taxilane Centerline and Edge of Apron	7.5 m [25 ft]	From taxilane centerline to edge of apron.
11	Clear Distance Around Refueling Aircraft	3 m [10 ft]	Outside of an area formed by lines connecting the tips of the blades and tail.
12	Paved Shoulders		See Table 4.4.
13	Clearance from Edge of Apron to Fixed and Mobile Obstacles	23 m [75 ft]	Measured from rear and side of apron. Distance to other aircraft operational pavements may require a greater clearance.
		30 m [100 ft]	For aprons regularly servicing H-53 helicopters.

Notes:

1. Metric units apply to new airfield construction and where practical modification to existing airfields and heliports, as discussed in paragraph 1.4.4.
2. The criteria in this manual are based on aircraft specific requirements and are not direct conversions from inch-pound (English) dimensions. Inch-pound units are included only as a reference to the previous standard.
3. Airfield and heliport imaginary surfaces and safe wingtip clearance dimensions are shown as a direct conversion from inch-pound to SI units.

6.8. Warm-Up Pads. A warm-up pad, also referred to as a holding apron, is a paved area adjacent to a taxiway at or near the end of a runway. The intent of a warm-up pad is to provide a parking location, off the taxiway, for aircraft which must hold due to indeterminate delays. It allows other departing aircraft unencumbered access to the runway.

6.8.1. Navy and Marine Corps. Warm up pads are not usually required at Navy facilities. Typically the end cross over taxiway is widened to 46 m [150 ft] which provides room to accommodate aircraft warming up or waiting for other reasons.

6.8.2. Location.

6.8.2.1. At End Turnoff Taxiway. The most advantageous position for a warm-up pad is adjacent to the end turnoff taxiway, between the runway and parallel taxiway, as shown in Figure 6.9. However, other design considerations such as airspace and navigational aids may make this location undesirable.

6.8.2.2. Along Parallel Taxiway. If airspace and navigational aids prevent locating the warm-up pad adjacent to the end turnoff taxiway, the warm-up pad should be located at the end of and adjacent to the parallel taxiway, as shown in Figure 6.10.

Figure 6.9. Warm-Up Pad at End of Parallel Taxiway.

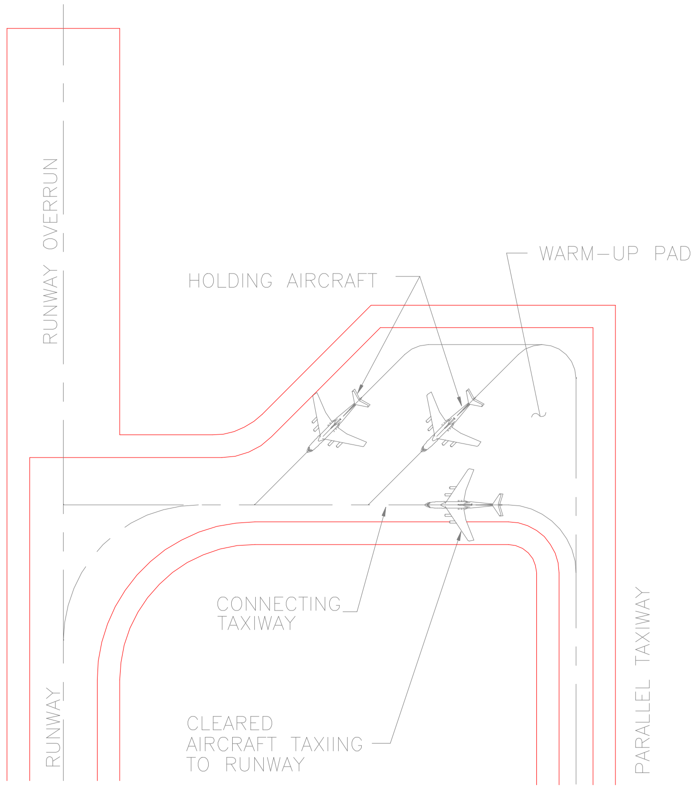
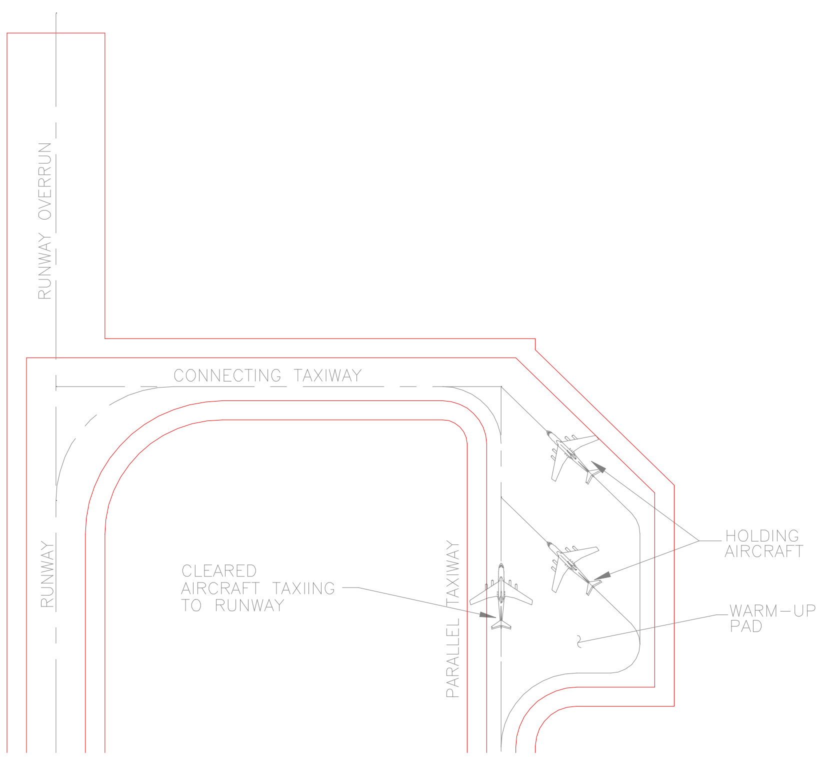


Figure 6.10. Warm-Up Pad Next to Parallel Taxiway.

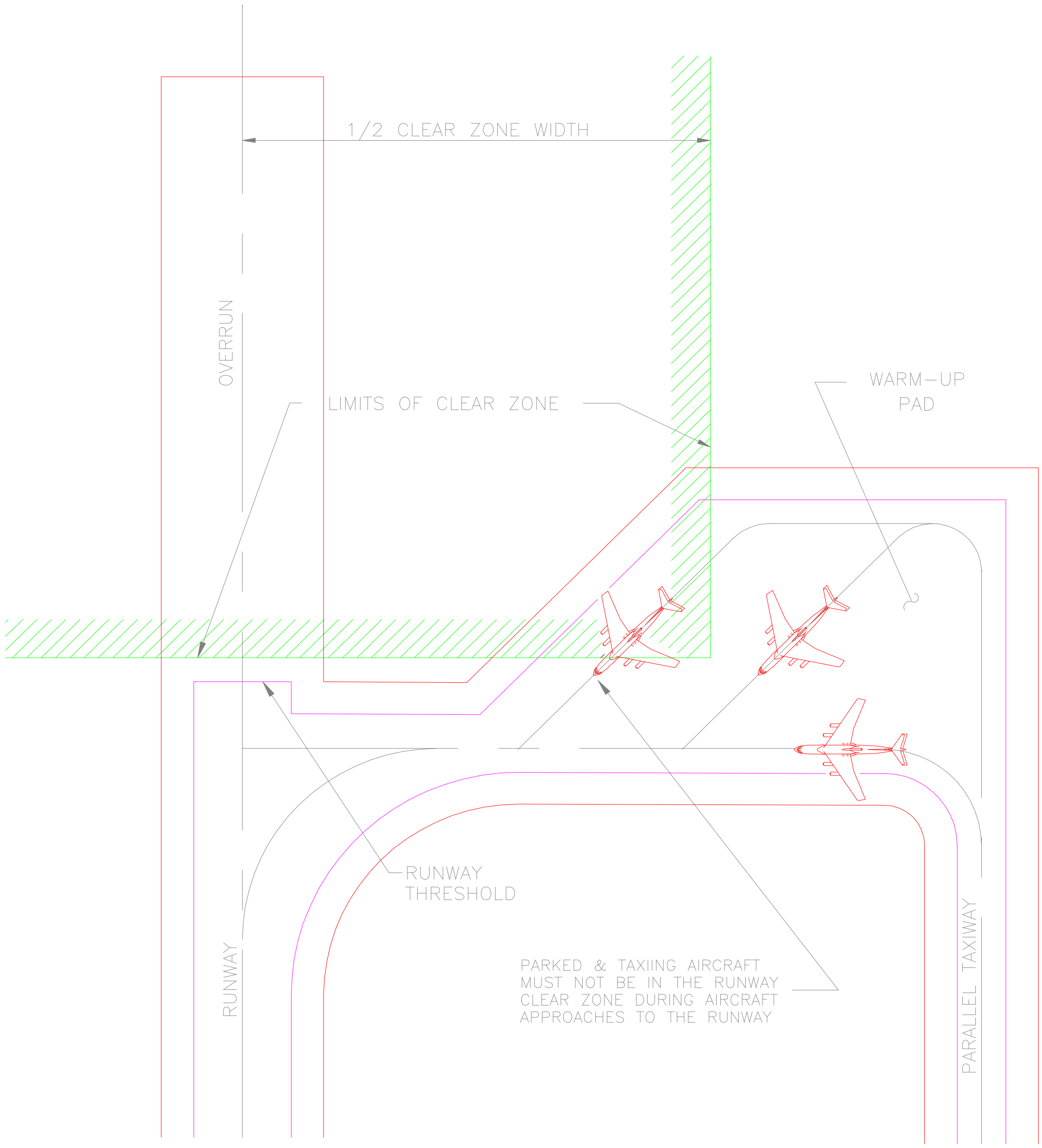


6.8.3. Siting Considerations.

6.8.3.1. End of Runway. Locate a warm-up pad as close to the runway as possible.

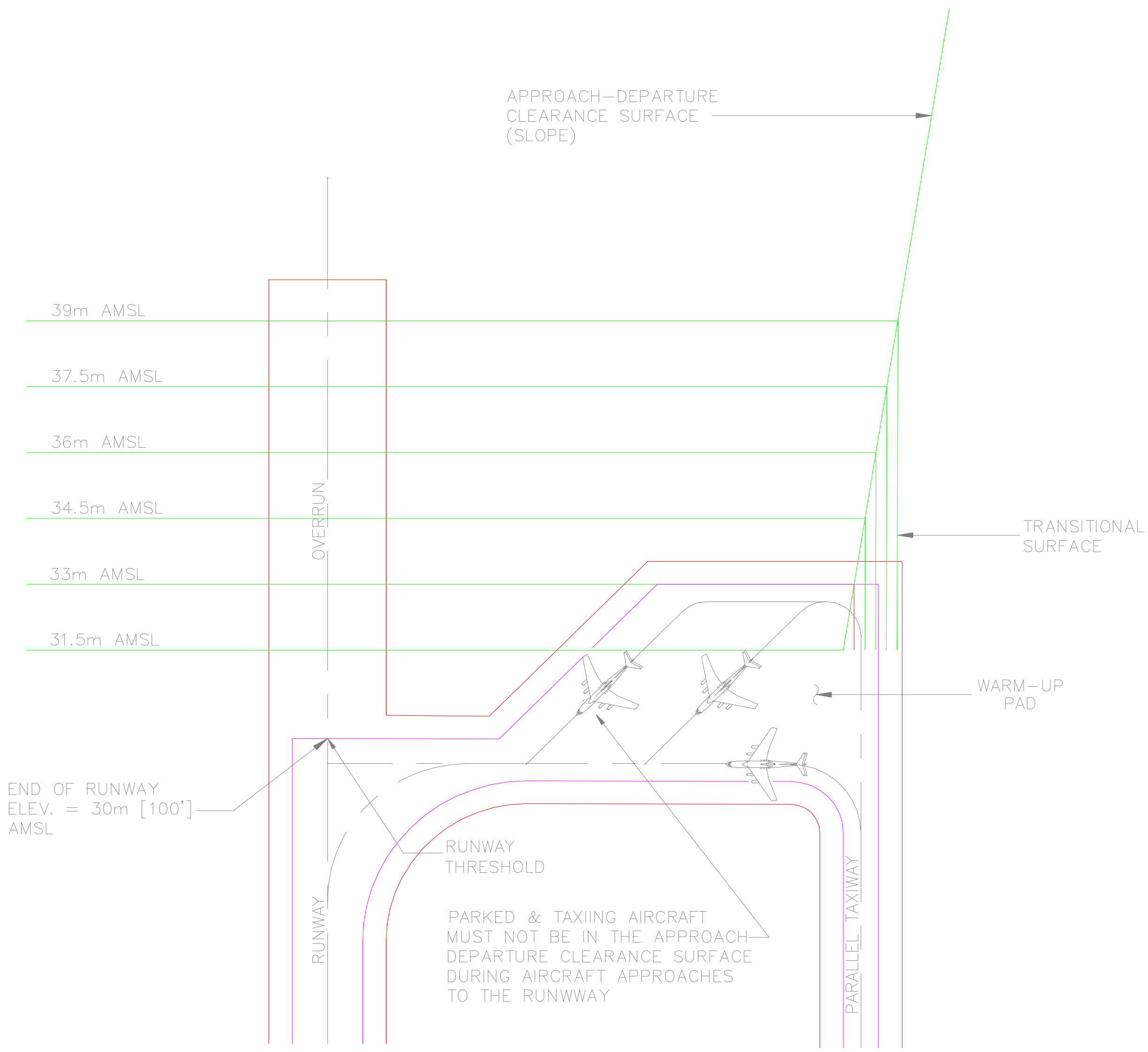
6.8.3.2. Clear Zone. As discussed in Chapter 3, a Clear Zone is an area on the ground which must be free of obstructions. Aircraft holding in or taxiing through a clear zone are considered a mobile obstruction and are not allowed in the clear zone when aircraft are on final approach to the runway. This is illustrated in Figure 6.11.

Figure 6.11. Warm-Up Pad Located in Clear Zone.



6.8.3.3. Airspace Imaginary Surfaces. As discussed in Chapter 3, an obstruction to air navigation occurs when the imaginary surfaces are penetrated. Aircraft on the warm-up pad could possibly penetrate the airspace imaginary surfaces. Aircraft penetrations may require revisions to TERPS procedures and instrument approach procedures. This is illustrated in Figure 6.12.

Figure 6.12. Warm-Up Pad Located in Approach-Departure Clearance Surface.



6.8.3.4. Navigational Aids (NAVAIDS). Warm-up pads must be located so they do not interfere with the operation of NAVAIDS, including ILS equipment and PAR facilities. To eliminate interference of the ILS signal by holding aircraft; holding aircraft, on or off a warm-up pad, must be outside the critical areas. The critical area for ILS equipment is illustrated in Figures 6.13, 6.14, and 6.15. Additional discussion on ILS critical areas is found in TM 5-823-4, *Marking of Army Airfield-Heliport Operational and Maintenance Facilities*, AFI 13-203, *Air Traffic Control*, and Air Force Engineering Technical Letter (ETL) 94-01, *Standard Airfield Pavement Marking Schemes.*

6.8.4. Warm-Up Pad Size. The size of the warm-up pad will be such to allow accommodating two of the largest aircraft assigned to the facility simultaneously. Wingtip clearances required by the clear distance information presented in Table 6.1.

Figure 6.13. Warm-Up Pad/Localizer Critical Area.

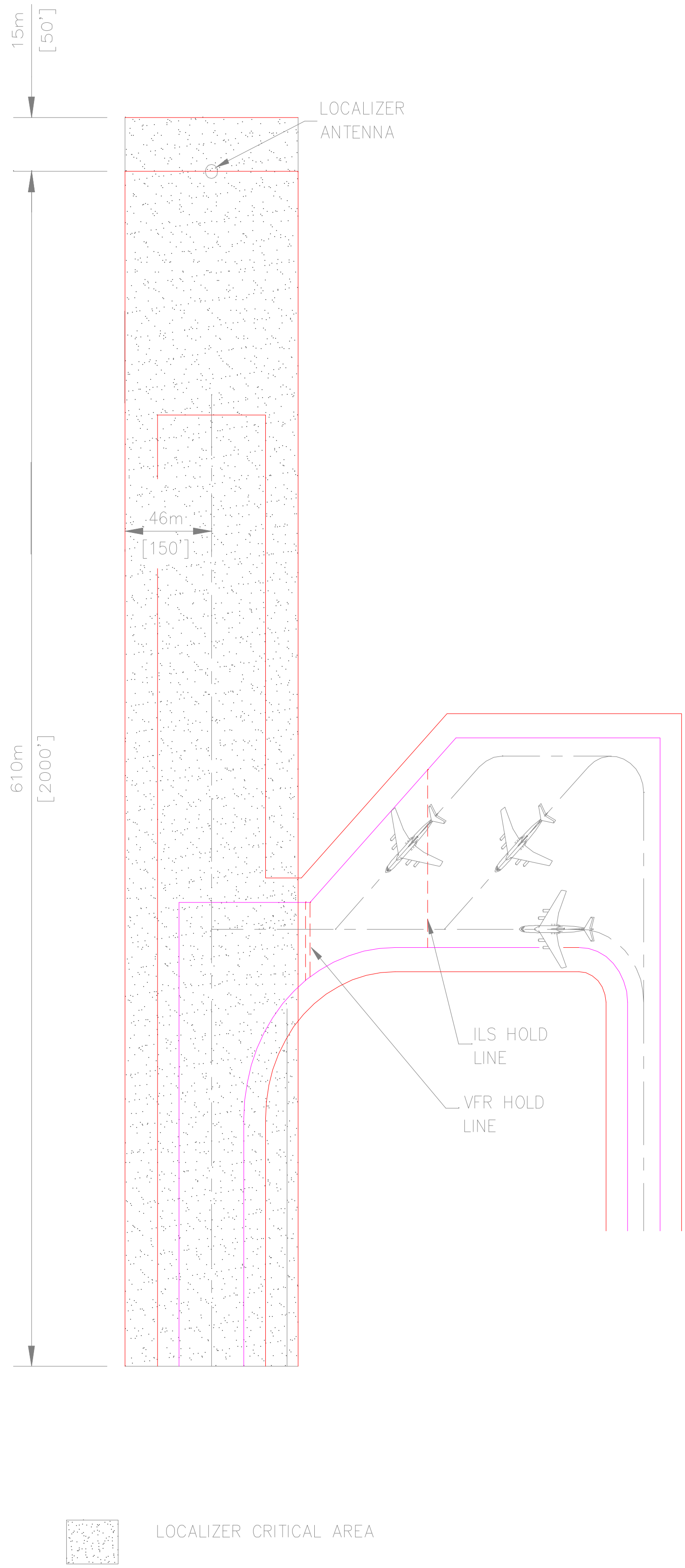


Figure 6.14. Air Force Warm-Up Pad/Glide Slope Critical Area.

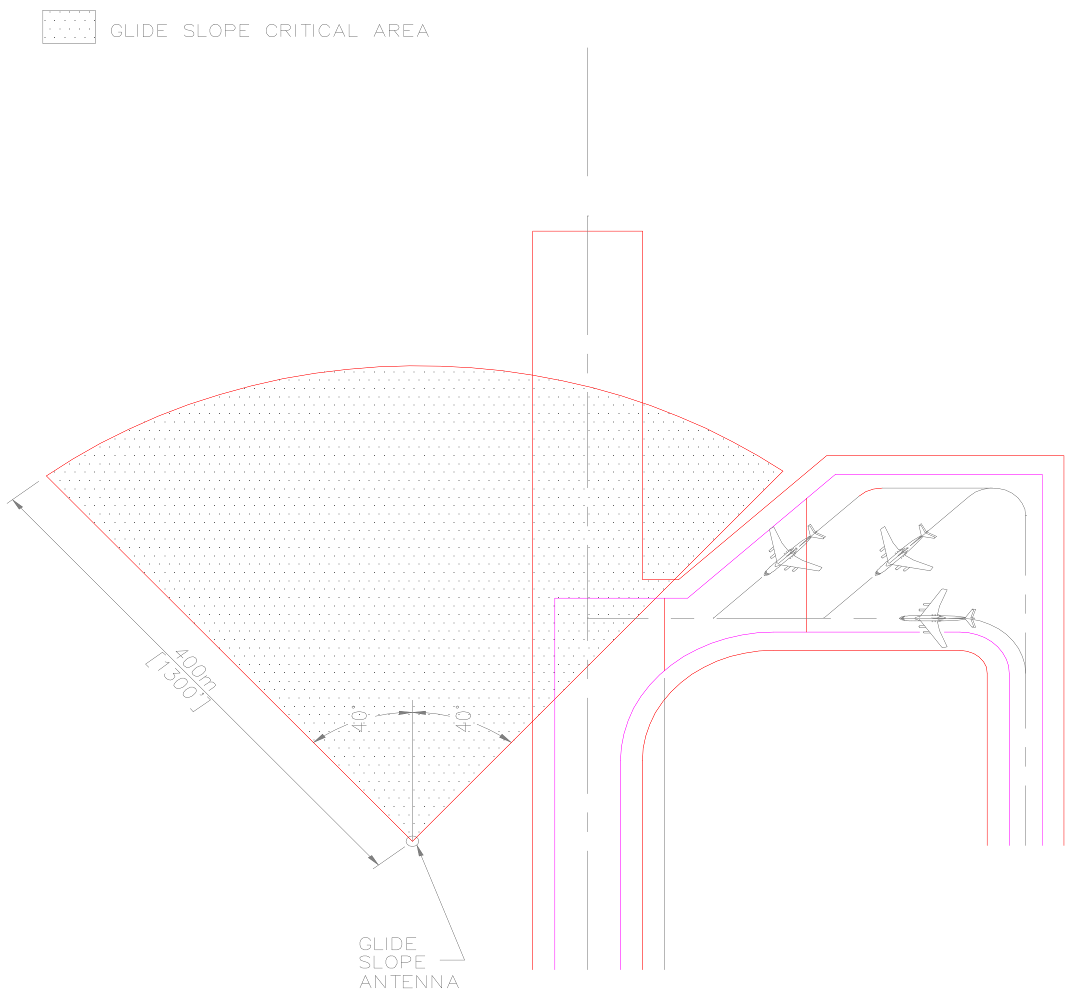
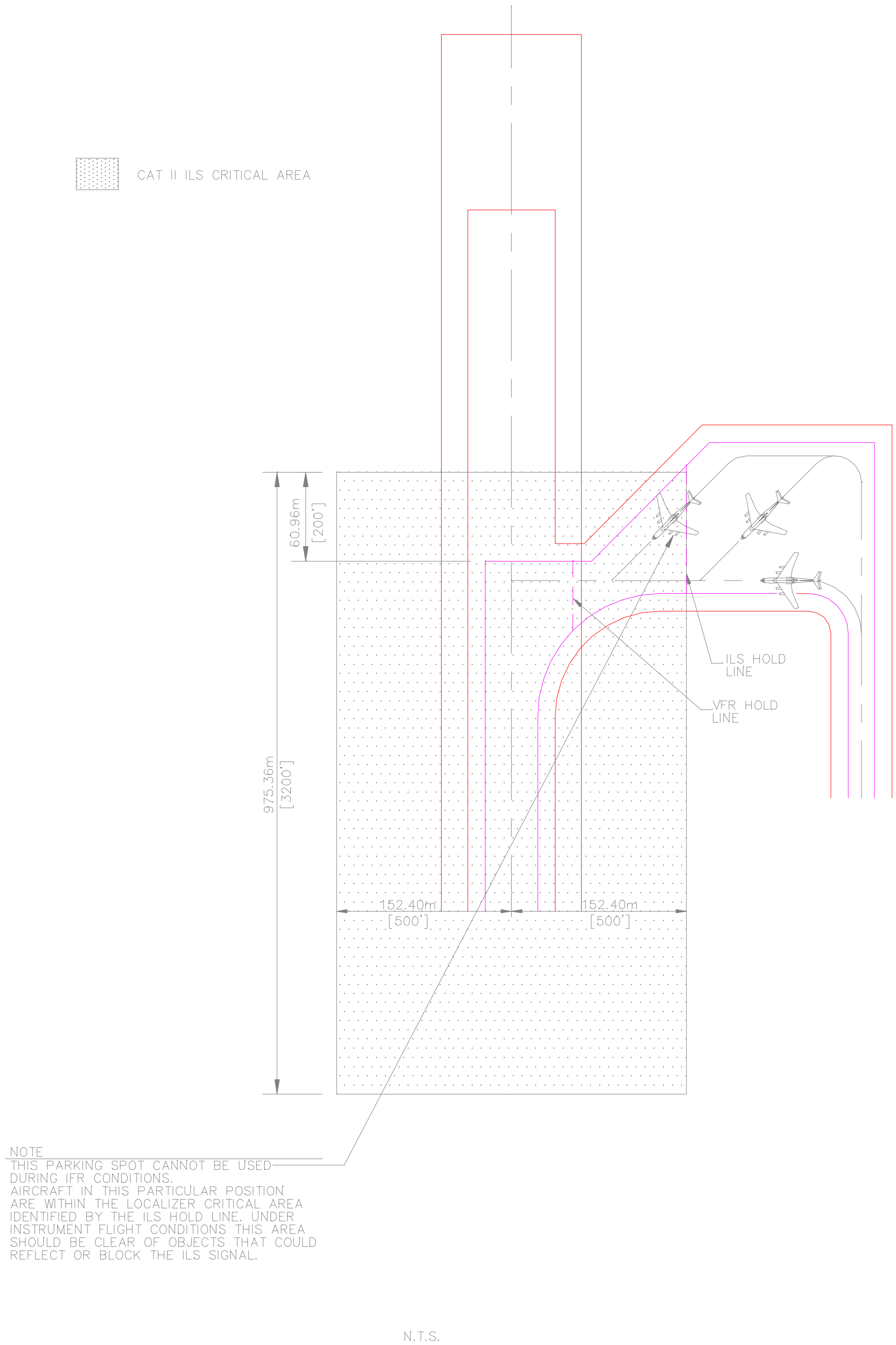


Figure 6.15. Warm-Up Pad/CAT II ILS Critical Area.



6.8.5. Taxi-In/Taxi-Out Capabilities. The parking locations will have taxi-in/taxi-out capabilities to allow aircraft to taxi to their warm-up position under their own power, as shown in Figure 6.16.

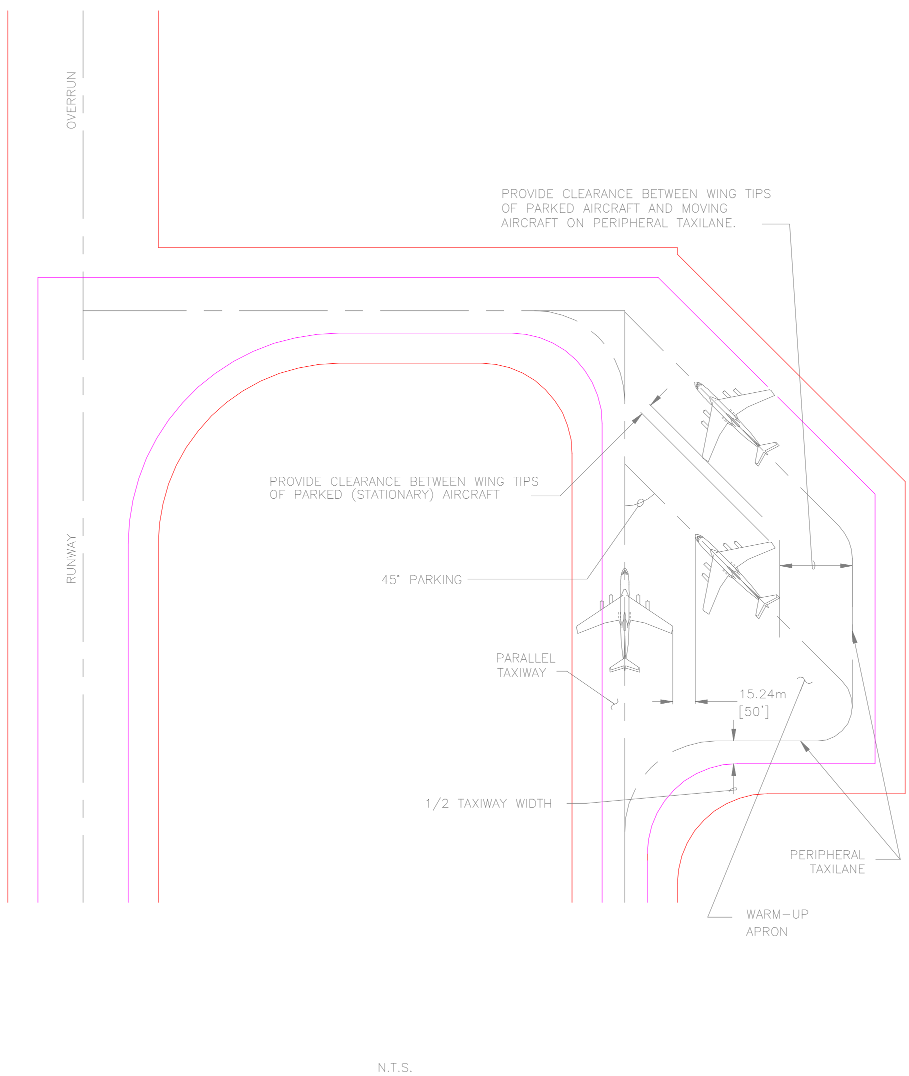
6.8.6. Parking Angle. Aircraft should be parked at a 45 degree (45°) angle to the parallel taxiway to divert the effects of jet blast away from the parallel taxiway. This is shown in Figure 6.16.

6.8.7. Turning Radius. The turning radius on warm-up pads will be designed to provide the minimum allowable turn under power for the largest aircraft assigned to the base.

6.8.8. Taxilanes on Warm-Up Pads. Taxilanes on the warm-up pad will meet the lateral clearance requirements discussed in Table 6.1. Lateral and wingtip clearance for a taxilane on a warm-up pad is illustrated in Figure 6.16.

6.8.9. Tie-Downs and Grounding Points. Tie-downs, mooring points and grounding points are not required on warm-up pads.

Figure 6.16. Warm-Up Pad Taxiing and Wingtip Clearance Requirements.



6.9. Power Check Pad. An aircraft power check pad is a paved area, with an anchor block in the center, used to perform full-power engine diagnostic testing of aircraft engines while the aircraft is held stationary.

6.9.1. Location and Siting Considerations. Unsuppressed power check pads should be located near maintenance hangars, but at a location where full power engine diagnostic testing of jet engines can be performed with minimal noise exposure to inhabited area's on and off the base.

6.9.2. Unsuppressed Power Check Pad Layout. Power check pads may either be rectangular, square or circular shaped.

6.9.2.1. Army and Air Force. Power check pad layouts for Army and Air Force aviation facilities are shown in Figures 6.17, 6.18 and 6.19.

6.9.2.2. Navy and Marine Corps. Power check pad layout for Navy and Marine Corps aviation facilities are found in NAVFAC Drawings 1404838-1404857.

Figure 6.17. Geometry for Rectangular Power Check Pad.

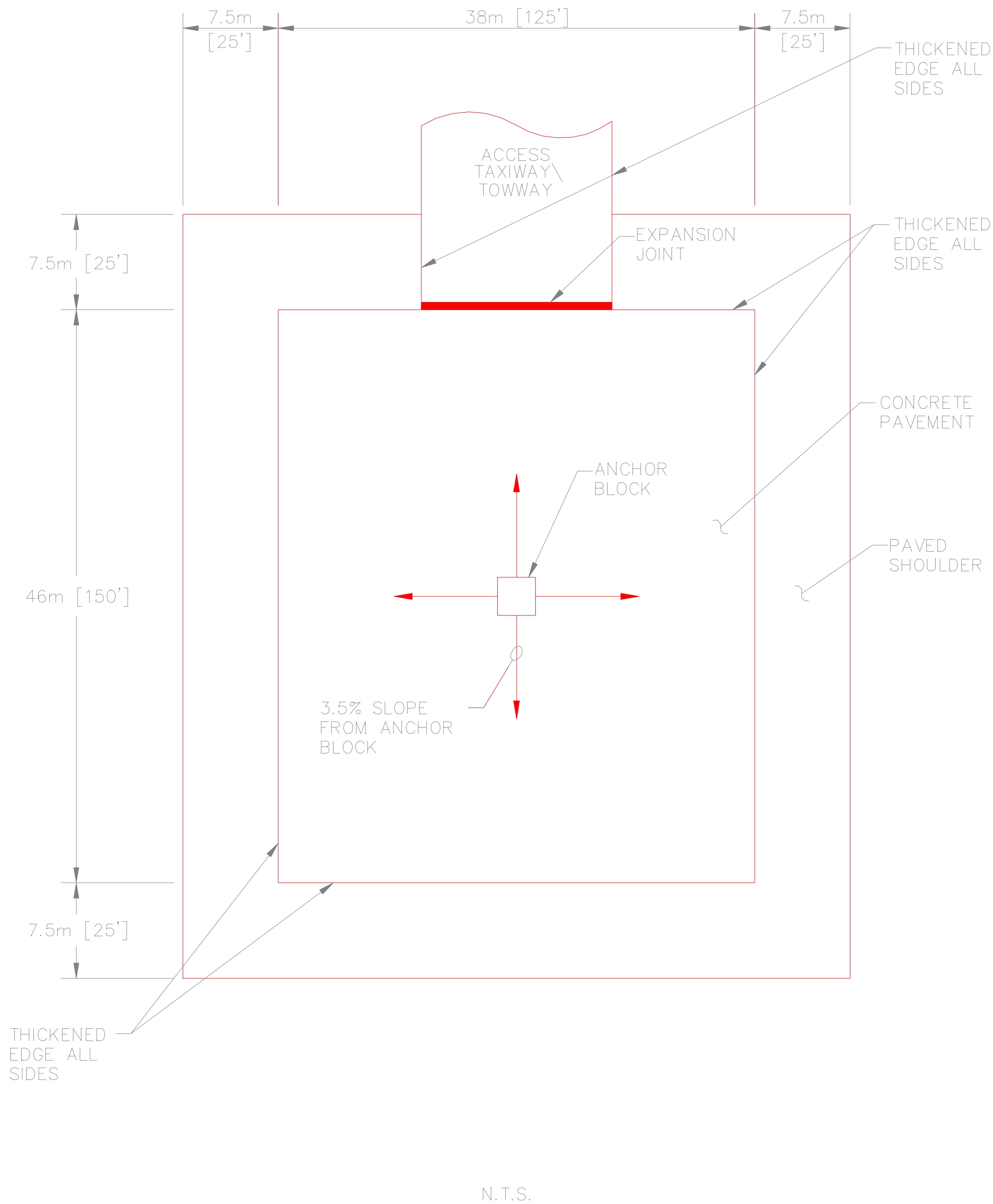


Figure 6.18. Geometery for Square Power Check Pad.

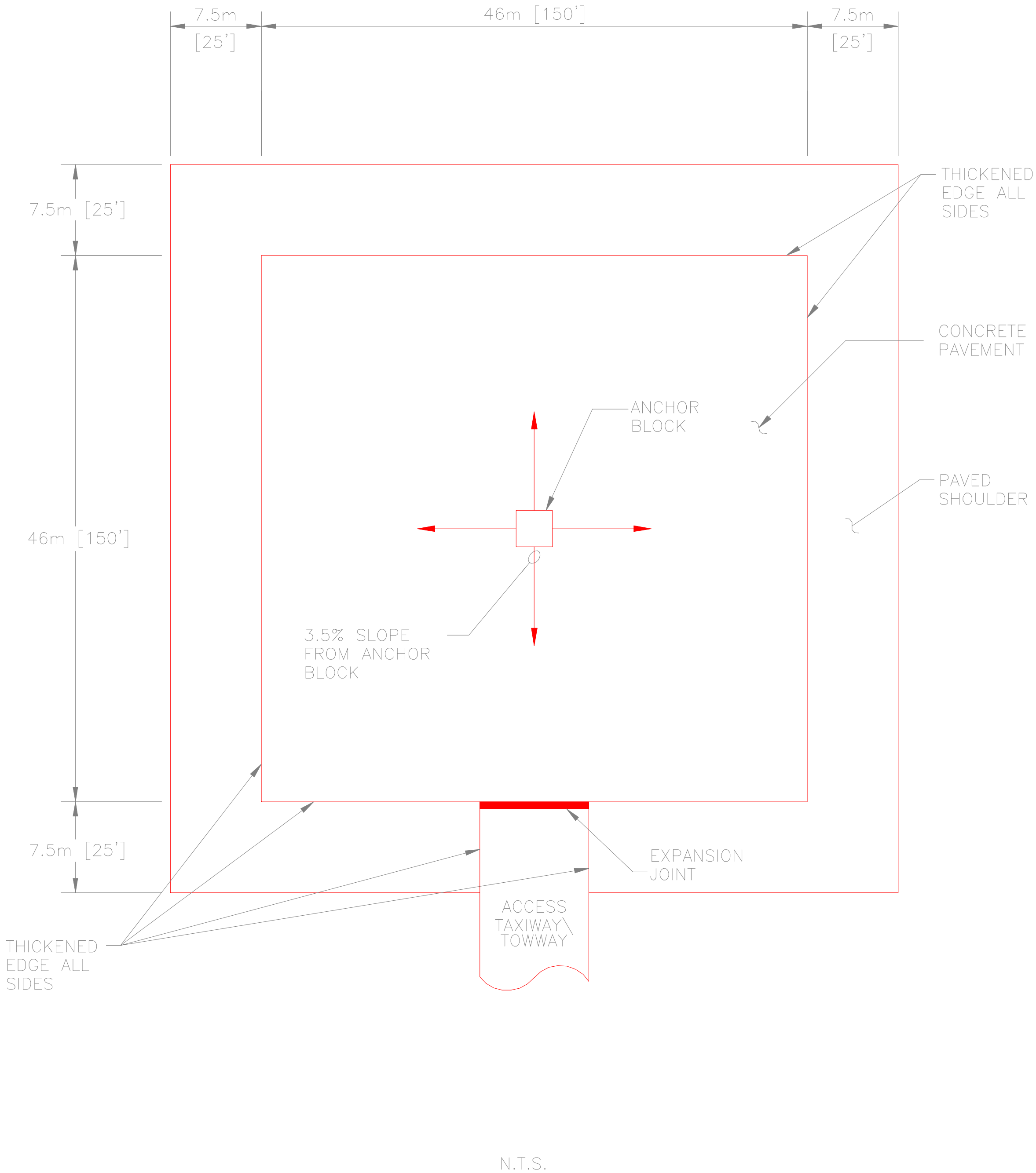
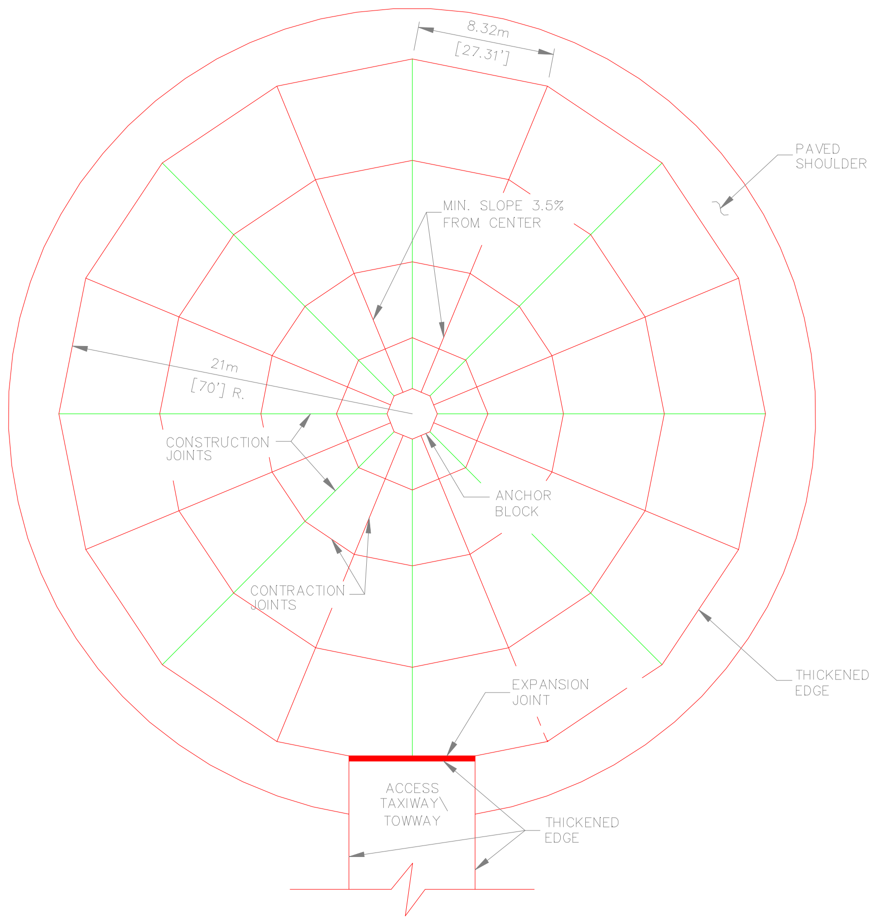


Figure 6.19. Geometry for Circular Power Check Pad.



6.9.3. Access Taxiway/Towway. An access taxiway will be provided for access from the primary taxiway to the power check pad. Since the aircraft may be towed to the unsuppressed power check pad, the access taxiway must be designed as a towway. Taxiway and towway design requirements are presented in Chapter 5.

6.9.4. Grading. The surface of the unsuppressed power check pad must slope 3.5 percent in all directions from the anchor block to pavement edge to divert the effect of jet blast away from the concrete surfaces and pavement joints.

6.9.5. Tiedowns/Mooring Points. Tiedowns (Air Force)/mooring points (Army)/tiedown mooring eyes (Navy and Marine Corps) are required on unsuppressed power check pads. Tiedowns/mooring points/tiedown mooring eyes layouts are interdependent of joint spacing and the two should be coordinated together.

6.9.5.1. Army and Air Force. Power check pad mooring point/tiedowns for Army and Air Force aviation facilities are found in Attachment 16.

6.9.5.2. Navy and Marine Corps. Power check pad tiedown mooring eye for Navy and Marine Corps aviation facilities are found in NAVFAC Drawings 1404838-1404857.

6.9.6. Anchor Blocks. All unsuppressed power check pads have a thrust anchor block installed in the center of the power check pad to anchor the aircraft during engine testing. Anchor blocks are structurally designed for each individual aircraft. The designer must verify structural adequacy of the anchor block for the mission aircraft and engine type.

6.9.6.1. Army and Air Force. Thrust anchor blocks for Army and Air Force aviation facilities are found in Attachment 16.

6.9.6.2. Navy and Marine Corps. Thrust anchor blocks for Navy and Marine Corps aviation facilities are found in NAVFAC Drawings 1404838-1404857.

6.9.7. Power Check Pad Facilities.

6.9.7.1. Required Facilities. The unsuppressed power check pad should consist of the following required items:

6.9.7.1.1. Paved surface.

6.9.7.1.2. Tiedowns.

6.9.7.1.3. Paved shoulders.

6.9.7.1.4. A thrust anchor or anchors for aircraft serviced at the pad.

6.9.7.1.5. Blast deflectors if required to protect the surrounding area from jet blast damage.

6.9.7.2. Optional Facilities. The unsuppressed power check pad may include the following items:

6.9.7.2.1. Floodlighting for night operations.

6.9.7.2.2. Water supply to wash down fuel spills.

6.9.7.2.3. Oil separators, holding tanks, and fuel treatment to address fuel spillage prior to discharge into sanitary or storm sewer.

6.9.7.2.4. Communication link with the maintenance control room.

6.9.7.2.5. Fire hydrants.

6.9.7.2.6. A paved roadway to the unsuppressed power check pad for access by fire fighting, towing and aircraft maintenance support vehicles.

6.9.8. Noise Considerations. The noise level at unsuppressed power check pads may exceed 115 dB(a) during power-up engine tests. Caution signs should be placed around the power check pad indicating both the presence of hazardous noise levels and the need for hearing protection.

6.10. Arm/Disarm Pads. The arm/disarm pad is used for arming aircraft immediately before takeoff and for disarming (safing) weapons retained or not expended upon their return.

6.10.1. Navy and Marine Corps Requirements. Navy and Marine Corps requirements for arm/disarm pads are found in P-80 and MIL-HDBK-1021/1, *General Concepts for Airfield Pavement Design*.

6.10.2. Location. Air Force arm/disarm pads should be located adjacent to runway thresholds and sited such that armed aircraft are oriented in the direction of least populated areas or towards revetments.

6.10.3. Siting Considerations:

6.10.3.1. Aircraft Heading. The criteria for establishing the exact heading of the parked aircraft depends on the type of aircraft and associated weapons. This information is contained within the classified portion of the aircraft manuals. The most economical means of parking aircraft on the arm/disarm pads is at 45 degrees (45°) to the taxiway. However, because of the requirement to orient armed aircraft away from populated areas, this angle may vary.

6.10.3.2. Inhabited Building Distance Clear Zone. As a general rule, an "inhabited building distance clear zone" of plus or minus 5 degrees (±5°) of arc on each side of the heading of the parked aircraft and 8.5 kilometers [5 miles] in the front of the parked aircraft, both measured from the aircraft's nose, should be maintained. This means that no occupied building will be in this clear zone. In addition, it is good practice to keep all buildings out of this clear zone to prevent damage from accidental weapon firing. This "inhabited building distance clear zone" may cross a runway, taxiway, or runway approach as long as the landing and taxiing aircraft can be seen by the arm/disarm quickcheck crews and the arming/disarming operations can cease for the period in which the aircraft passes. Parked aircraft or parked vehicles must not be located in the "inhabited building distance clear zone." If this clear zone cannot be obtained, earth revetments should be used as a barrier.

6.10.3.3. Electromagnetically Quiet Location. Prior to construction of any pad, local field measurements must be taken to ensure that the location is electromagnetically quiet. To avoid potential electromagnetic interference from taxiing aircraft, pads should be located on the side of a runway opposite the parallel taxiway. Navy and Marine Corps aviation facilities must have an EMC background study by NISE EASE CHSN, as described in NAVAIR 16-1-529, *Electromagnetic Radiation Hazards.*

6.10.4. Arm/Disarm Pad Size. Each arm/disarm pad should be capable of servicing four or six aircraft at a time. The dimensions of the pad may vary with the length and wingspan of the aircraft to be served. Typical layout of arm/disarm pads are shown in Figures 6.20, 6.21, 6.22 and 6.23.

6.10.5. Taxi-In/Taxi-Out Capabilities. The parking locations should have taxi-in/taxi-out capabilities to allow aircraft to taxi to their arm/disarm location under their own power.

6.10.6. Parking Angle. The parking angle is dependent on the type of aircraft, type of weapons and the associated "uninhabited clear zone" location.

6.10.7. Turning Radius. The turning radius for taxilanes on arm/disarm pads should be designed to provide the minimum allowable turn under power of the largest aircraft which will use the arm/disarm pad.

6.10.8. Access Road. An all-weather access road should be constructed to the arm/disarm pad outside the airfield's taxiway and runway clearance areas. Design of this road will be in accordance with AFM 88-7/TM 5-822-2, *General Provisions and Geometric Design for Roads, Streets and Open Storage Areas*, Chapters 3 and 5, and AFM 88-7/TM 5-822-6, *Pavement Design for Roads, Streets, and Open Storage Areas*, Chapter 1.

6.10.9. Tiedowns and Grounding Points. Tiedowns and mooring points are not required on arm/disarm pads. See Attachment 12 for grounding requirements.

6.10.10. Ammunition and Explosives Safety Standards. Ammunition and explosive safety standards are discussed in Attachment 10.

Figure 6.20. Arm-Disarm Pad for F-4 Fighter.

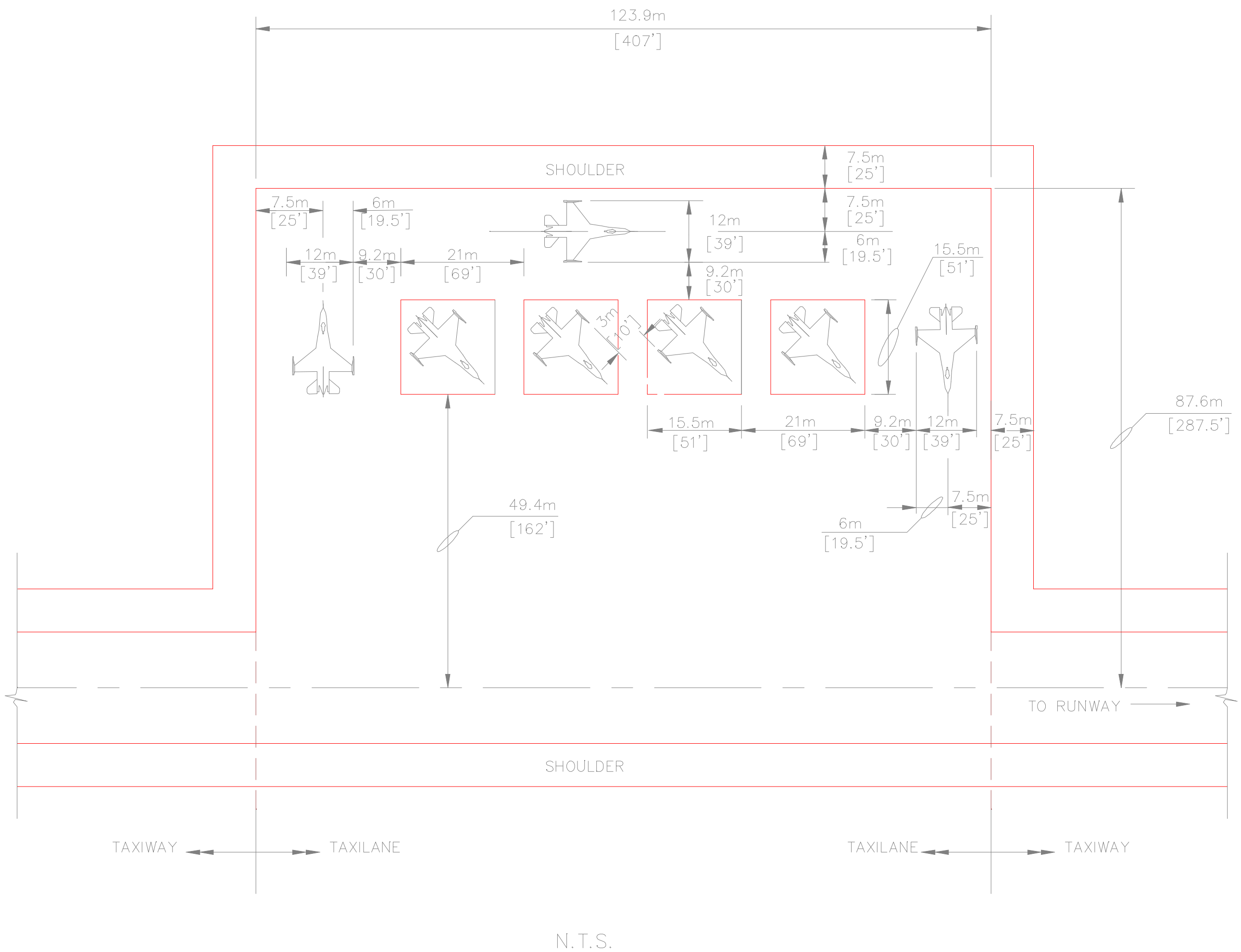


Figure 6.21. Arm-Disarm Pad for F-15 Fighter.

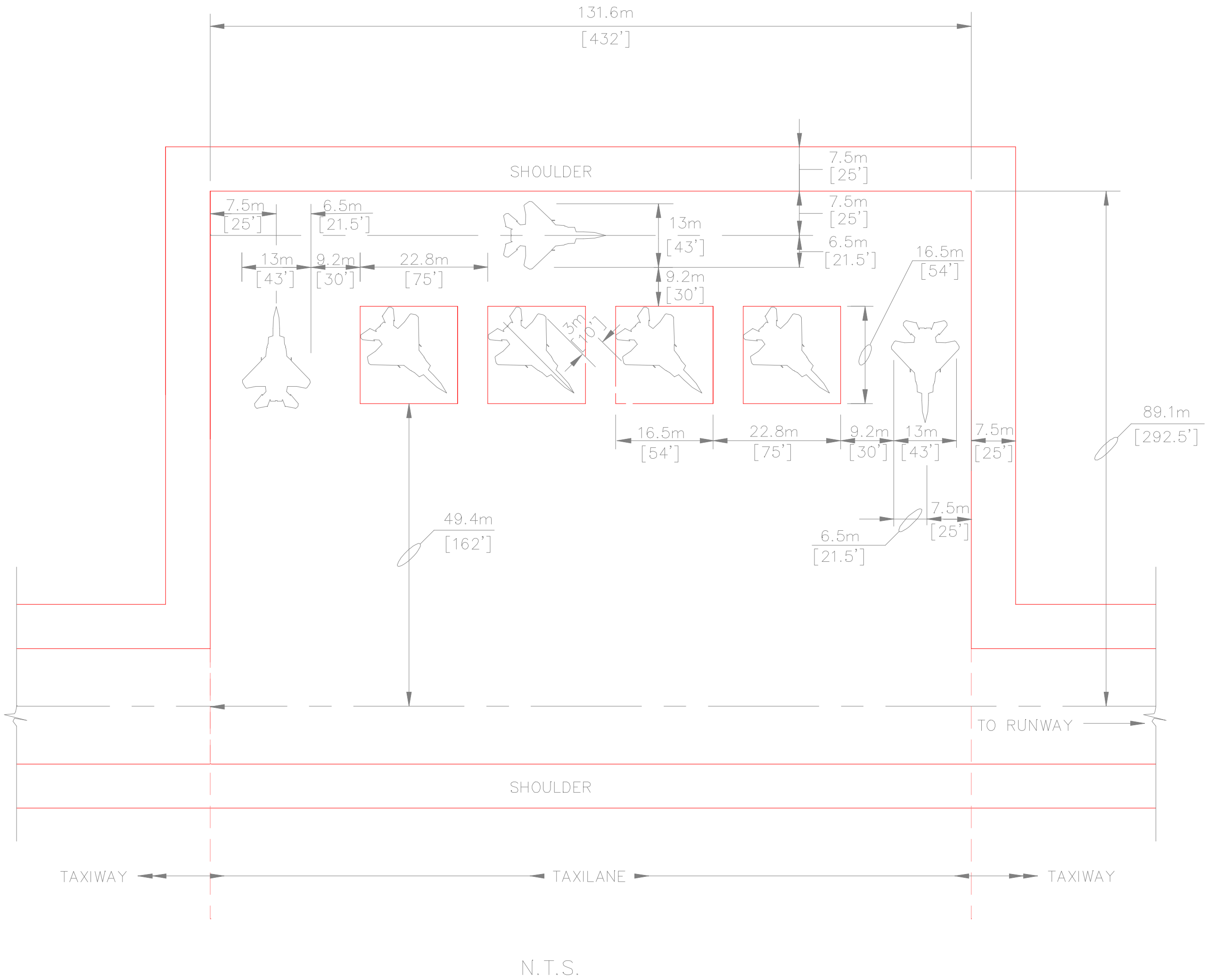


Figure 6.22. Arm-Disarm Pad for F-16 Fighter.

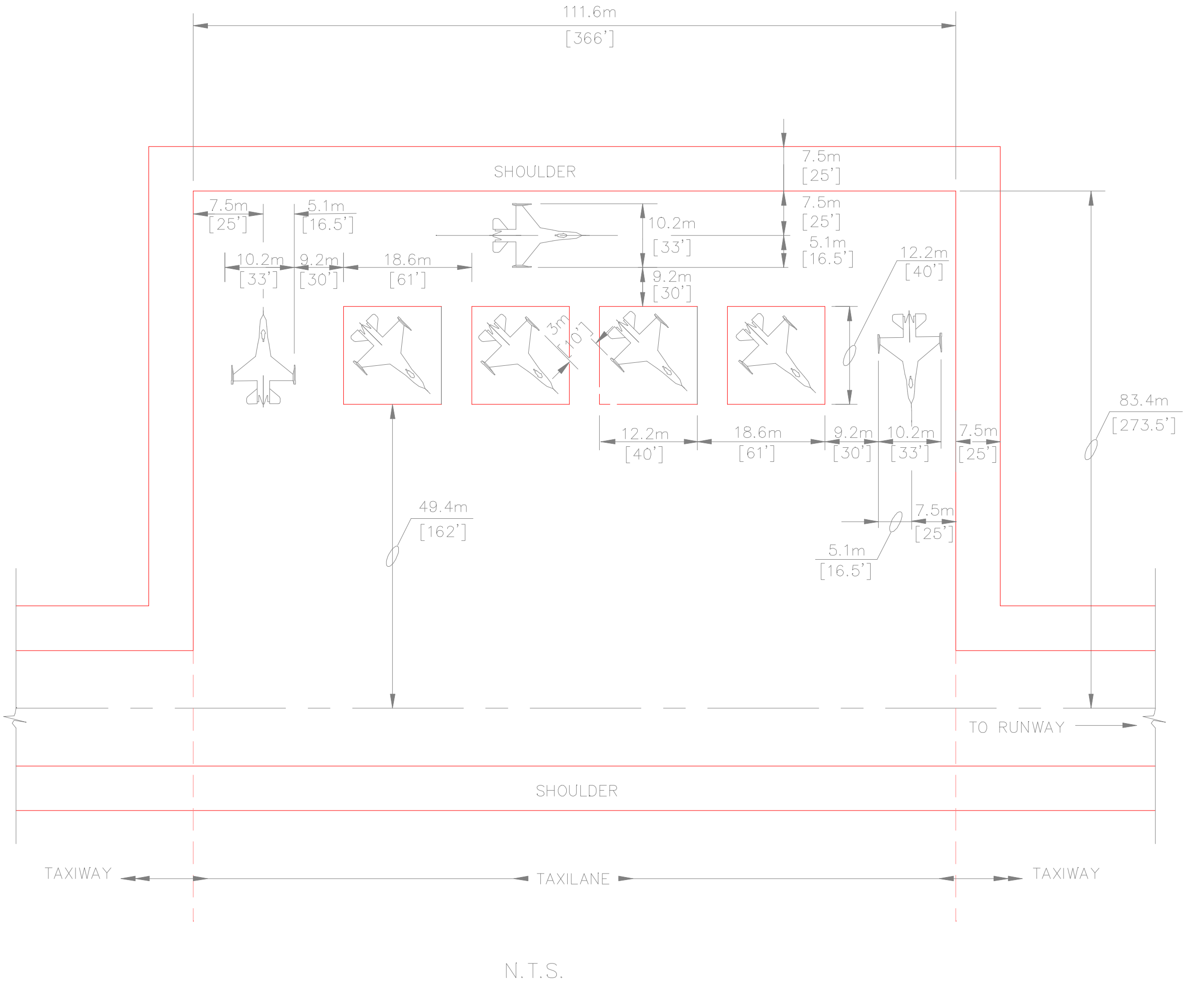
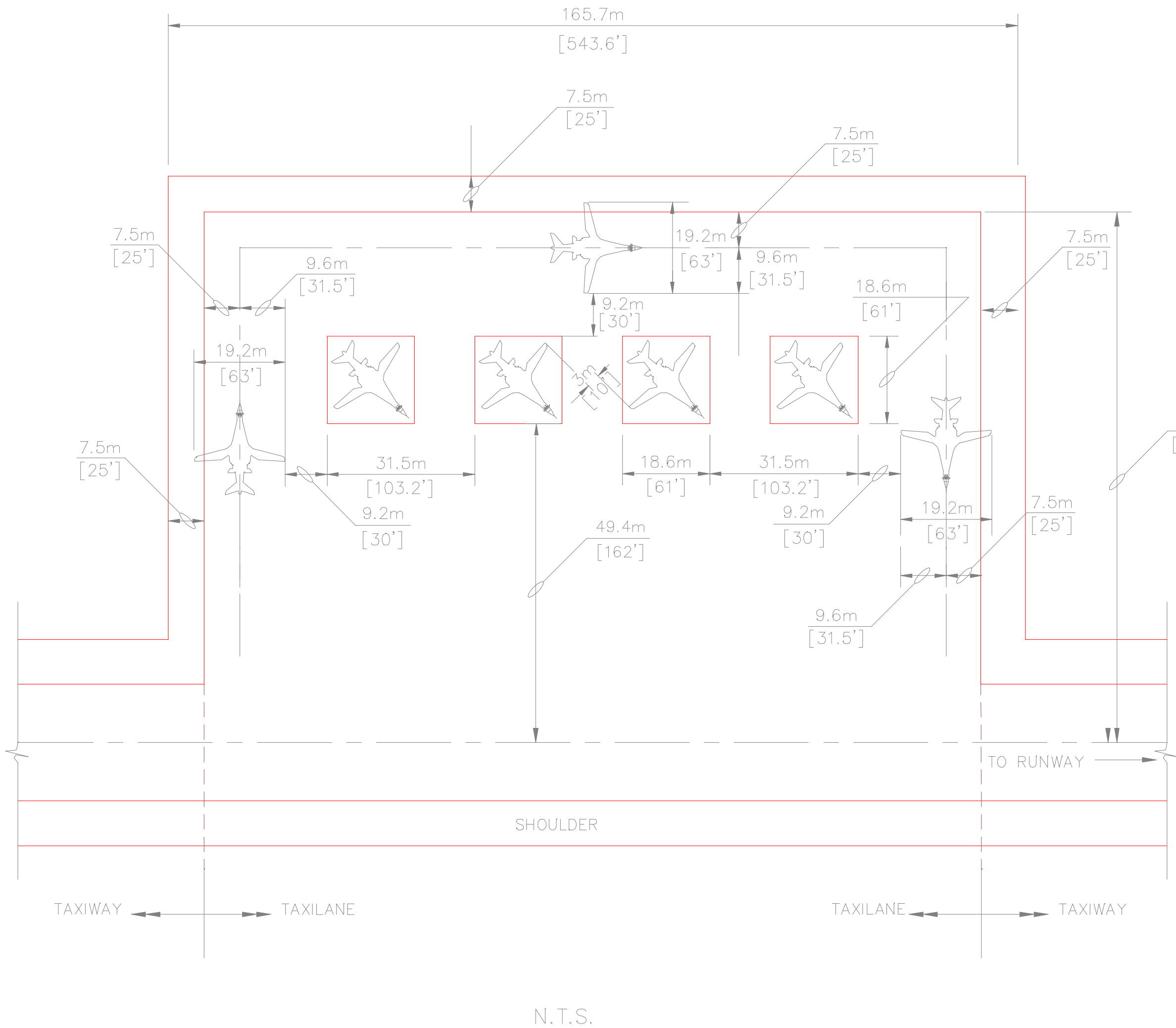


Figure 6.23. Arm-Disarm Pad for F-111 Fighter.



6.11. Compass Calibration Pad (CCP). An aircraft compass calibration pad is a paved area in a magnetically quiet zone where an aircraft's compass is calibrated.

6.11.1. Air Force. The Air Force has the option of using the criteria presented here or using the criteria provided within Federal Aviation Administration (FAA) Advisory Circular 150/5300-13, Appendix 4. A current copy of the FAA AC 150/5300-13, *Airport Design)*, Appendix 4, can be obtained from HQ AFCESA/CESC. For compass calibration pad marking requirements, use the controlling aircraft Technical Order or use the information within FAA AC 150/5300-13 for general purpose compass calibration pads.

6.11.2. Navy and Marine Corps. Prior to construction or major repair of a compass calibration pad, a validation of need shall be filed through the maintenance department to the Naval Air Systems Command for approval. Navy and Marine Corps requirements for Compass Calibration Pads are found in P-80, *Facility Planning Factor Criteria for Navy and Marine Corps Shore Installations*, and MIL-HDBK-1021/1.

6.11.3. Location. The compass calibration pad should be located off the side of a taxiway at sufficient distance to satisfy the runway and taxiway lateral clearance distance and airspace criteria discussed in Chapters 3, 4, and 5.

6.11.4. Siting Consideration:

6.11.4.1. Separation Distances. To meet the magnetically quiet zone requirements and prevent outside magnetic fields from influencing the aircraft compass calibration, efforts must be taken to make sure that the center of the pad meets the minimum separation distances listed below:

6.11.4.1.1. Army and Air Force:

6.11.4.1.1.1. 68.6 meters [225 feet] to underground metal conduits or metal piping, including reinforced concrete pipe (RCP).

6.11.4.1.1.2. 83.8 meters [275 feet] from the edge of the nearest taxiway; to the edge of the nearest roadway traffic lane or vehicle driveway; and to the edge of aircraft or vehicle parking apron.

6.11.4.1.1.3. 152.4 meters [500 feet] to underground alternating current (ac) power lines including runway/taxiway edge lighting.

6.11.4.1.1.4. 182.9 meters [600 feet] to overhead steam lines; to overhead conduits or metal piping; to overhead a.c. power lines; to any ac equipment; to the nearest edge of any railroad track; to the nearest fire hydrant; and to the nearest portion of any building.

6.11.4.1.1.5. 304.8 meters [1,000 feet] to any direct current (dc) power line or equipment including underground and above ground telephone lines.

6.11.4.1.2. Navy and Marine Corps. Criteria for separation distances for Navy and Marine Corps compass calibration pad is given in MIL-HDBK-1021/1.

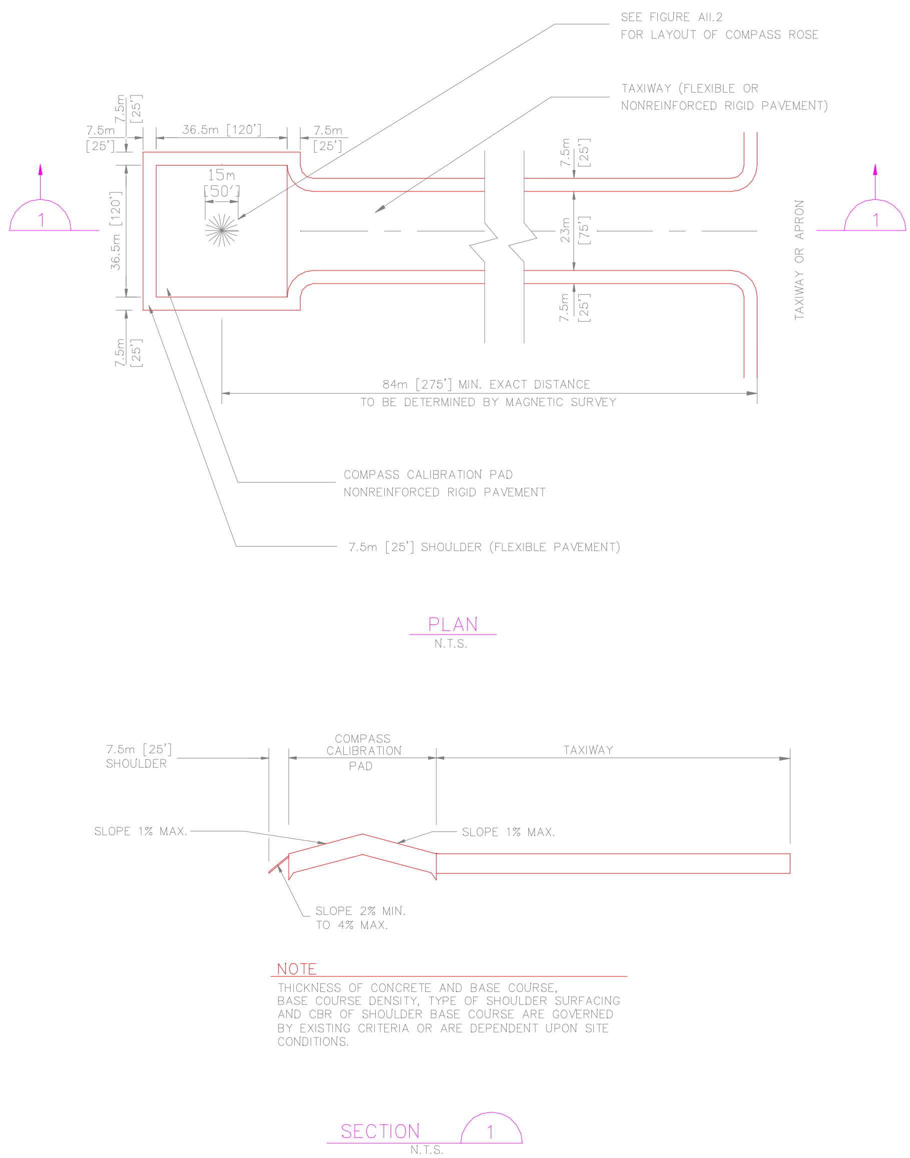
6.11.4.2. Preliminary Survey. During the site selection process, the proposed sites for compass calibration pads must be checked for magnetic influences to insure that the area is magnetically quiet regardless of adherence to separation distances. A preliminary survey as described in Attachment 11 must be conducted to determine if the proposed site is magnetically quiet. A survey, similar to the preliminary survey, must be conducted after construction of any new item, building, within or near the separation distances of the pad. This will assure that the newly constructed item has not created new magnetic influences in the magnetically quiet zone.

6.11.4.3. Magnetic Survey. The magnetic survey for the compass calibration pad is an airfield engineering survey that is conducted at the completion of the pad to assure that the area is magnetically quiet, to determine the magnetic declination of the area, and to layout the markings for the pad. Engineering surveys are also required every five (5) years for Army and Air Force compass calibration pads and every year for Navy and Marine Corps compass calibration pads. This cycle is operationally important as the magnetic north not only varies at different locations on the earth, but physically changes as a function of time. It is an operational requirement to calibrate the aircraft's compass correction factor on a regular basis because of these changes in the earth's magnetic pole. In addition, the magnetic survey validates that the compass calibration pad is in a magnetically quiet zone; thus insuring proper compass calibration. The magnetic survey for compass calibration pads should be performed in accordance with Attachment 11.

6.11.5. Compass Calibration Pad Size:

6.11.5.1. Army and Air Force. Army and Air Force compass calibration pad size is shown in Figure 6.24.

Figure 6.24. Army and Air Force Compass Calibration Pad.



6.11.5.2. Navy and Marine Corps. Navy and Marine Corps compass calibration pad size is provided in MIL-HDBK-1021/1.

6.11.6. Access Taxiway/Towway. An access taxiway will be provided for access from the primary taxiway to the compass calibration pad. The access taxiway must be oriented to facilitate moving the aircraft onto the compass calibration pad on a magnetic north heading. At Army and Air Force aviation facilities, if the aircraft should be towed to the compass calibration pad, the access taxiway must be designed as a towway. At Navy and Marine Corps facilities, the taxiway should be designed as a taxiway. Taxiway and towway design requirements are presented in Chapter 5.

6.11.7. Grading. Compass calibration pads will be graded as follows:

6.11.7.1. Perimeter Elevation. The elevation of the perimeter of the pad will be the same elevation around the entire perimeter.

6.11.7.2. Cross-slope:

6.11.7.2.1. Army and Air Force. The compass calibration pad should be crowned in the center of the pad with a constant cross slope of 1 percent in all directions to provide surface drainage while facilitating alignment of the aircraft pad.

6.11.7.2.2. Navy and Marine Corps. Grading criteria for compass calibration pads is found in MIL-HDBK-1021/1.

6.11.8. Tiedowns/Mooring Points. No aircraft tiedown/mooring points/tiedown mooring eyes, or any static grounding points must be placed in the compass calibration pad pavement.

6.11.9. Embedded Material. Due to the influence of ferrous metal on a magnetic field, the PCC pavement for the compass calibration pad and access taxiway must not contain any embedded ferrous metal items such as dowels bars, reinforcing steel, steel fibers, or other items. In addition, ferrous metal must not be placed in or around the compass calibration pad site.

6.11.10. Control Points. A control point will be set in the center of the compass calibration pad. This point will consist of a brass pavement insert into which a bronze marker is grouted in accurate alignment. This point will be stamped with "Center of Calibration Pad." The layout of the control points is further discussed in Attachment 11.

6.12. Hazardous Cargo Pads. Hazardous cargo pads are paved areas for loading and unloading explosives and other hazardous cargo from aircraft. Hazardous cargo pads are required at facilities where the existing aprons cannot be used for loading and unloading hazardous cargo.

6.12.1. Navy and Marine Corps Requirements. Hazardous cargo pads are not normally required at Navy and Marine Corps facilities. However, where operations warrant or there is an Air Force hazardous cargo aircraft continuously present, they can be justified with proper documentation.

6.12.2. Siting Criteria. Hazardous cargo pads require explosives site planning as discussed in Attachment 10.

6.12.3. Hazardous Cargo Pad Size:

6.12.3.1. Circular Pad. At aviation facilities used by small cargo aircraft, the hazardous cargo pad is a circular pad as shown in Figure 6.25.

6.12.3.2. Semi-Circular Pad. At aviation facilities used by large cargo aircraft and Aerial Ports of Embarcation (APOE) and Aerial Ports of Debarcation (APOD), the hazardous cargo pad is a semi circular pad as shown in Figure 6.26. The semi-circular pad is adequate for aircraft up to and including the dimensions of the C-5.

6.12.3.3. Other Pad Size. The hazardous cargo pad geometric dimensions as shown in Figures 6.25 and 6.26 are minimum requirements. Hazardous cargo pads may be larger than these dimensions if the design aircraft cannot maneuver on the pad. Sources for obtaining information concerning minimum turning radii for various aircraft is presented in Army ETL 1110-3-394, *Aircraft Characteristics for Airfield-Heliport Design and Evaluation*.

6.12.4. Access Taxiway. An access taxiway will be provided for access from the primary taxiway to the hazardous cargo pad. The taxiway should be designed for the aircraft to taxi into the hazardous cargo pad under its own power.

6.12.5. Tiedown and Grounding Points. Tiedowns/mooring points/tiedown mooring eyes must be provided on each hazardous cargo pad. Grounding points must be provided on each hazardous cargo pad. Tiedown and grounding points are further discussed in Attachment 12.

Figure 6.25. Hazardous Cargo Pad Other Than APOE/Ds.

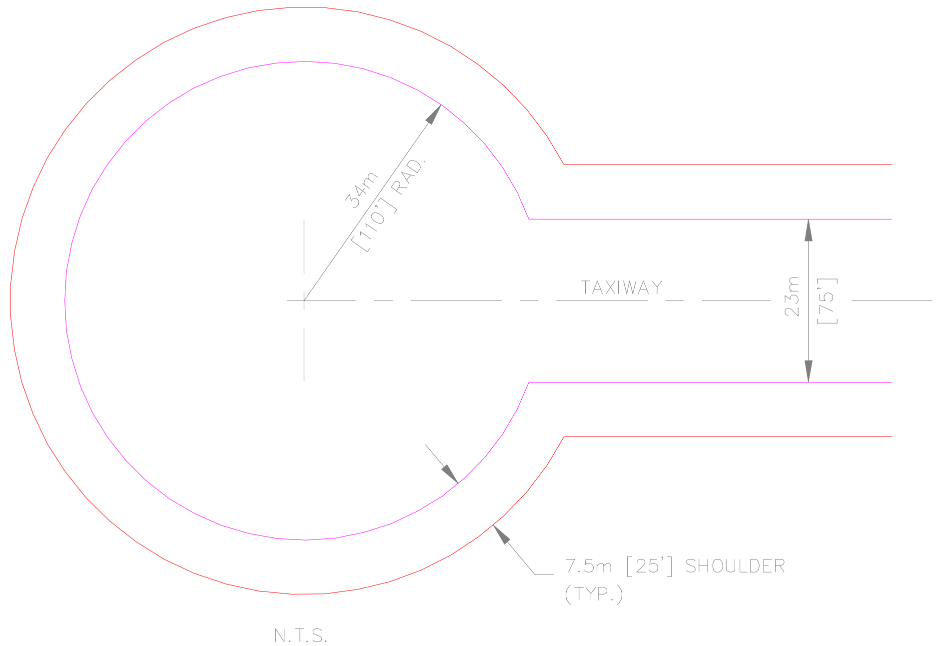
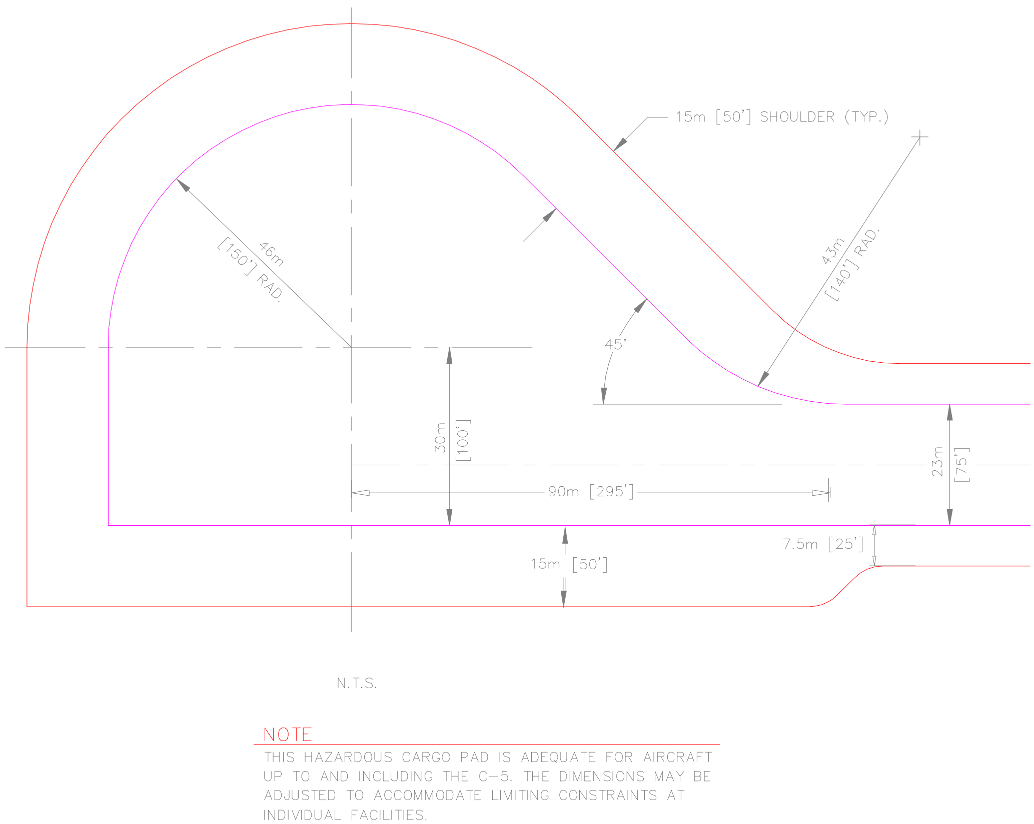


Figure 6.26. Typical Hazardous Cargo Pad for APOE/Ds.



6.12.6. Miscellaneous Considerations. The following items need to be considered for hazardous cargo pads:

6.12.6.1. Utilities. Telephone service, apron lighting, airfield lighting and water/fire hydrants are required for safety.

6.12.6.2. Access Road. Consideration should be given to providing a paved roadway to the hazardous cargo pad for access by trucks and other vehicles.

6.13. Alert Pad. An alert pad, often referred to as an alert apron, is an exclusive paved area for armed aircraft to park and have immediate, unimpeded access to a runway. In the event of a declared alert, alert aircraft must be on the runway and airborne in short notice. This chapter will refer to both alert aprons and alert pads as "alert pads." An alert apron is shown in Figure 6.27. An alert pad is shown in Figure 6.28.

Figure 6.27. Typical Alert Apron for Bombers and Tanker Aircraft.

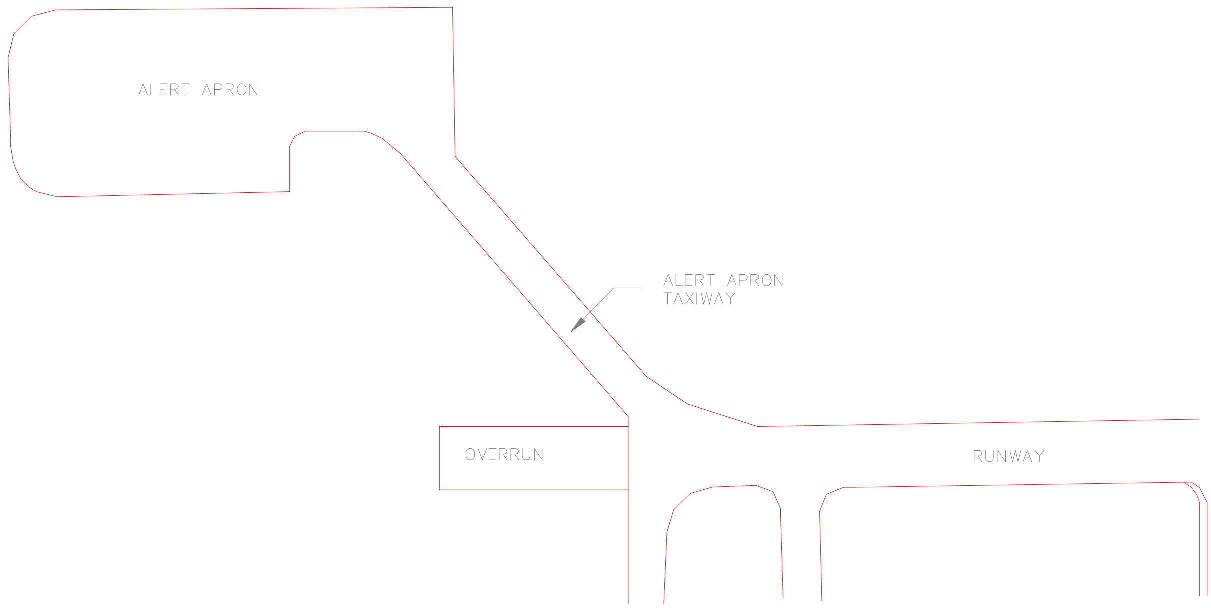
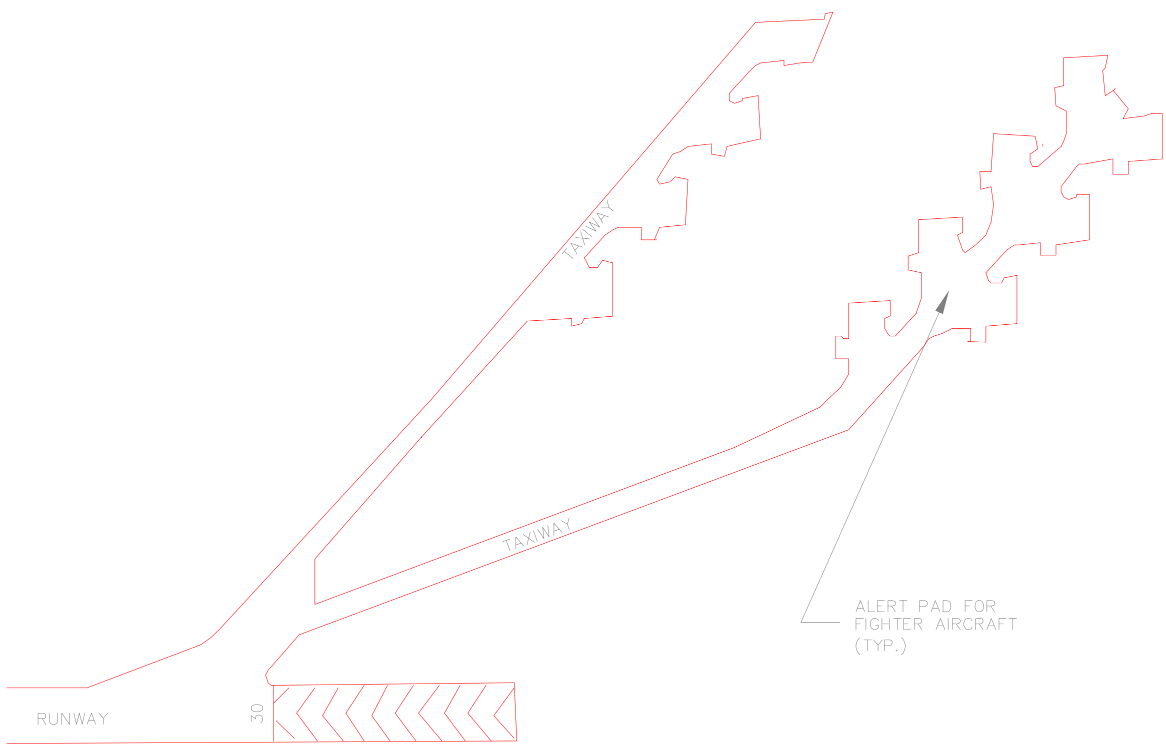


Figure 6.28. Typical Alert Pad for Fighter Aircraft.



6.13.1. Navy and Marine Corps Requirements. Alert Pads are not normally required at Navy and Marine Corps facilities. When justified, this criterion will be used.

6.13.2. Location. Locating the alert pad adjacent to a runway end will allow alert aircraft to proceed directly from the apron to the runway threshold without interruptions from other traffic. Alert pads must be located close to the runway threshold to allow alert aircraft to be airborne within the time constraints stipulated in their mission statements. The preferred location of alert pads is on the opposite side of the runway, away from normal traffic patterns to allow aircraft on the alert pad direct, unimpeded access to the runway.

6.13.3. Siting Criteria:

6.13.3.1. Clear Zone. As discussed in paragraph 6.8.3.2, alert pads must not be located within the runway clear zone.

6.13.3.2. Airspace Imaginary Surfaces. As discussed in paragraph 6.8.3.3, aircraft parked on the alert pads must not project into airspace imaginary surfaces.

6.13.3.3. Explosives Consideration. Aircraft on alert pads loaded with explosives should be located to minimize the potential for explosive hazards. Explosives safety site plans must be prepared for explosive loaded alert aircraft. See Attachment 10.

6.13.4. Alert Pad Size. Alert pads should be sized to park all of the aircraft on alert. The dimensions of the pad should vary with the length and wingspan of the aircraft to be served and the explosives on the aircraft. Wingtip clearances, presented in Table 6.3, are minimum separation distances to be observed at all times.

Table 6.3. Minimum Separation Distance on Bomber Alert Aprons from the Centerline of a Through Taxilane to a Parked Aircraft.

AIRCRAFT	Standard (Meters)	Standard (Feet)	Minimum (Meters)	Minimum (Feet)
B-52 or B-52 Mixed Force B-1 B-2	45.72	150	38.10	125
KC-135 or KC-135 and FB-111 Mixed Force	38.10	125	30.48	100
KC-10 FB-111 Only	30.48	100	22.86	75

For additional discussion on separation distances, see paragraph 6.14.4.

6.13.4.1. Air Force Waivers:

6.13.4.1.1. Wingtip Clearances. The MAJCOM may grant waivers to the 15.24 meters [50 feet] wingtip clearance requirement when sufficient ramp area is not available. In no case will the wingtip clearance be waived to less than 9.14 meters [30 feet].

6.13.4.1.2. Wingtip Clearances Based on Taxilane Width. When the minimum separation distance between a taxilane centerline and the nose/tail of a parked aircraft is reduced below the distance shown in Table 6.1, the minimum waiver wingtip clearance distance of 9 meters [30 feet] must be increased 0.3 meters [1 foot] for each 0.3 meter [1 foot] reduction in separation distance. Example: B-52 nose to taxilane centerline 43 meters [140 feet] - minimum waiver wingtip distance 12 meters [40 feet]; nose to centerline distance 40 meters [130 feet] or less - no waiver permitted, comply with 15 meter [50 foot] minimum wingtip clearance.

6.13.5. Design Aircraft. To facilitate flexibility in future operations, new alert ramp construction should conform to B-52 standards. Aircraft parked in shelters are exempt from the above parking separation criteria.

6.13.6. Alert Aircraft Parking Arrangements:

6.13.6.1. Fighter Arrangements. Fighter aircraft are parked at 45-degree angles to dissipate the heat and velocity of jet blast.

6.13.6.2. Non-Fighter Arrangements. Non-fighter aircraft should be parked in rows.

6.13.7. Jet Blast Distance Requirements. Jet blast safe distances should be considered when planning and designing parking locations on alert pads. Safe distance criteria are presented in Attachment 8.

6.13.8. Taxi-In/Taxi-Out Capabilities. Alert aprons and pads should be designed either for taxi-in/taxi-out parking or for push-back parking. Taxi-in/taxi-out parking, shown in Figure 6.29, is preferred since alert aircraft can be quickly taxied into position under their own power. Back-in parking, shown in Figure 6.30, requires less paved area.

Figure 6.29. Alert Apron Taxi-In/Taxi-Out Parking.

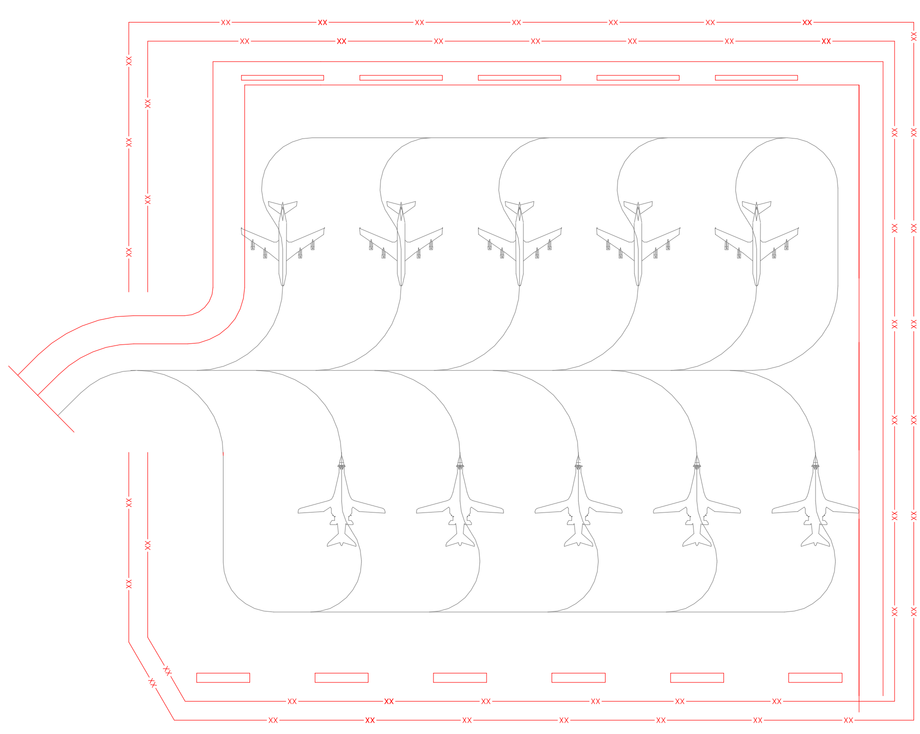
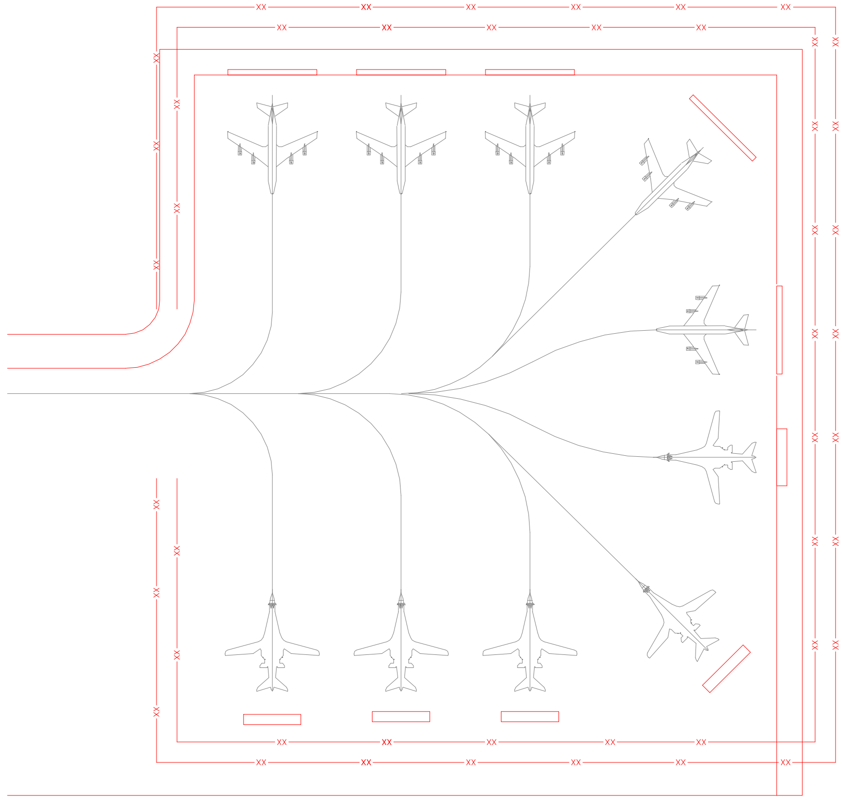


Figure 6.30. Alert Apron Back-In Parking.



6.13.9. Turning Radius. The turning radius on the alert pad taxilanes will be designed to provide the minimum allowable turn under power of the largest aircraft which will use the alert pad. In no case will the initial turnout from the alert apron parking space to the through taxilane exceed 90 degrees. For Air Force alert pad for bombers and tankers, the initial turn from the parking space will have a turn equal to the distance from the taxilane centerline to the nose of the aircraft. This is shown in Table 6.1.

6.13.10. Dedicated Access Taxiway. At alert pads, provide a single dedicated taxiway from the alert pad to the runway for aircraft to progress directly without traffic interruptions. Having no other taxiways intersect the dedicated taxiway is the ideal way to ensure the dedicated taxiway is not obstructed.

6.13.11. Tiedowns and Grounding Points. Tiedowns/mooring points/tiedown mooring eyes and grounding points will be provided at each aircraft parking location, as discussed in Attachment 12.

6.14. Aircraft Wash Racks. Aircraft wash racks are paved areas provided at all facilities to clean aircraft in conjunction with periodic maintenance and to prevent corrosion.

6.14.1. Location. Covered and uncovered aircraft wash racks should be located adjacent to the hangar area or maintenance facilities and contiguous to aircraft parking or access aprons. Existing pavements can be used where curbing can be installed, drainage adjusted as necessary, and other required facilities such as utilities, can be provided to make a usable wash rack. Where possible, wash racks should be located near existing facilities where existing utility and pollution control systems are accessible. In siting wash racks, support facilities such as pump houses and tanks should be located either outside apron clearance distances or below grade.

6.14.2. Wash Rack Size. The size and configuration of an aircraft wash rack is determined by the type of mission aircraft expected to use it. The dimensions of the largest aircraft plus the clearances shown in Table 6.4 determine the minimum wash rack pavement dimensions. At mixed mission facilities, it may be possible to accommodate several smaller (fighter) aircraft on one larger aircraft wash rack pavement.

Table 6.4. Wash Rack Clearances From Aircraft to Curb.

Aircraft	From	To	Direction	Distance (Meters)	Distance (Feet)
Heavy Bomber, Medium Bomber, and Cargo	Wingtip	Curb	Horizontally	4.6	15
	Tail	Curb	Horizontally	4.6	15
	Nose	Curb	Horizontally	4.6	15
Fighter	Wingtip	Curb	Horizontally	3.1	10
	Tail	Curb	Horizontally	3.1	10
	Nose	Curb	Horizontally	3.1	10
Helicopter	Rotor-tip	Curb	Horizontally	See note 1.	See note 1.
	Tail	Curb	Horizontally	See note 2.	See note 2.
	Nose	Curb	Horizontally	See note 3.	See note 3.

Notes:

1. For light to medium helicopter (UH-60 baseline), width of wash rack is based on the addition of 3.1 m [10-feet] buffers to the rotor diameter. For heavy helicopter (CH-47 Baseline), width of wash rack is based on the addition of 3.1 m [10-feet] buffers to the rotor diameter. For wash racks servicing multiple aircraft a 6.1 m (20-feet) buffer is required between rotor-tips.
2. 3.1 m [10-feet] for light and medium helicopter (UH-60 baseline). 10.4 m [34-feet] for heavy helicopter (CH-47 baseline).
3. 6.7 m [22-feet] for light and medium helicopter (UH-60 baseline). 10.4 m [34-feet] for heavy helicopter (CH-47 baseline).

6.14.2.1. Army and Air Force. Typical wash rack layouts for heavy bomber, medium bomber, cargo aircraft, fighter aircraft, and helicopters are shown in Figures 6.31 through 6.36.

6.14.2.2. Navy and Marine Corps. Typical type "A" and type "B" wash rack layouts for Navy and Marine corps aircraft are shown in Figures 6.34 and 6.35 and on NAVFAC drawing 1291729.

6.14.3. Wash Rack Facilities. The wash rack should consist of the following required items:

6.14.3.1. Paved surface.

6.14.3.2. Concrete curbs.

6.14.3.3. Paved shoulder (for rotary-wing only).

6.14.3.4. In-pavement structures.

6.14.3.5. Wastewater collection.

6.14.3.6. Wastewater treatment.

6.14.3.7. Utility control building.

6.14.3.8. Utilities.

Figure 6.31. Wash Rack for Mixed Mission Facility.

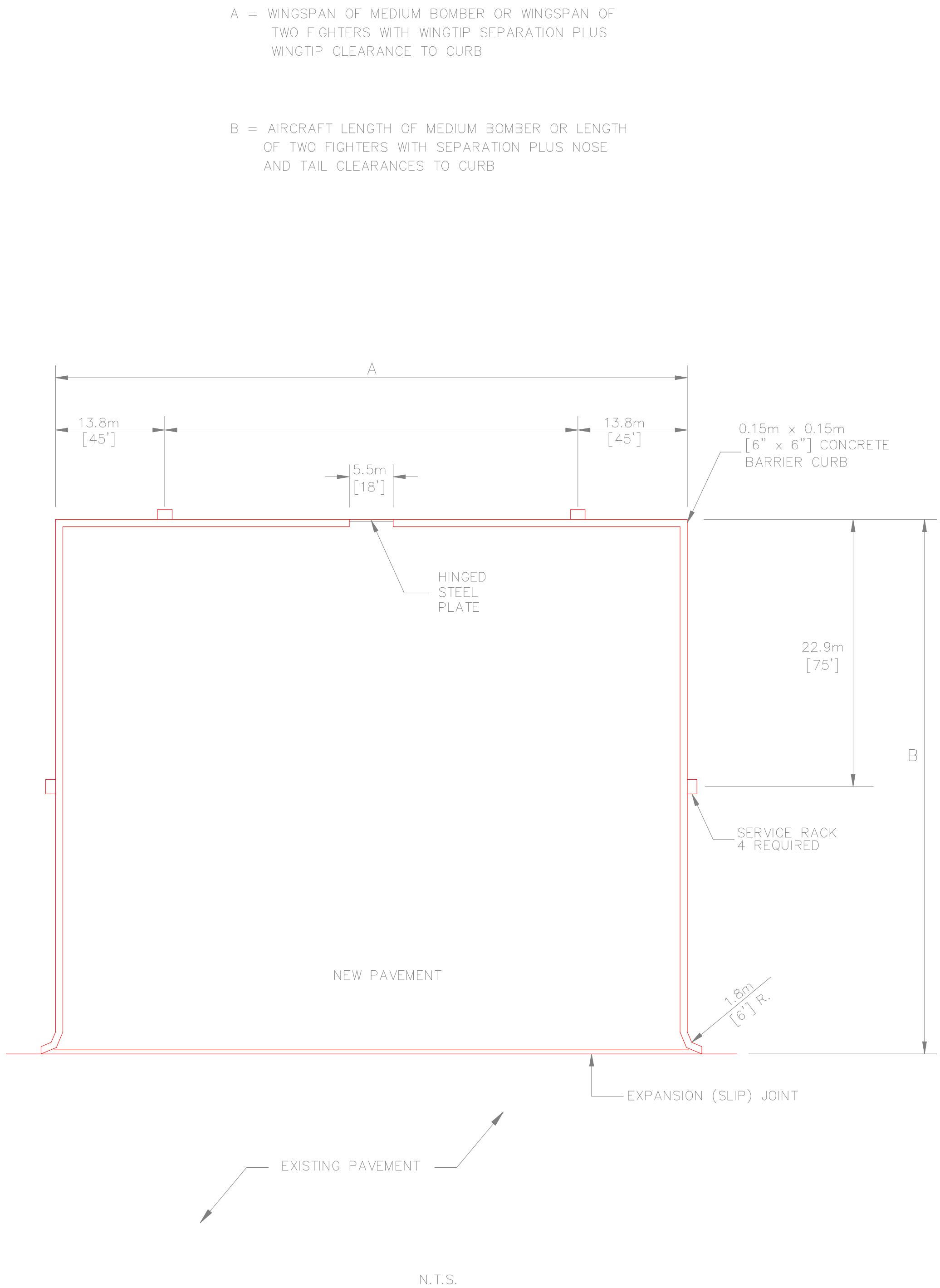


Figure 6.32. Heavy Bomber Wash Rack (B-52 or B-1).

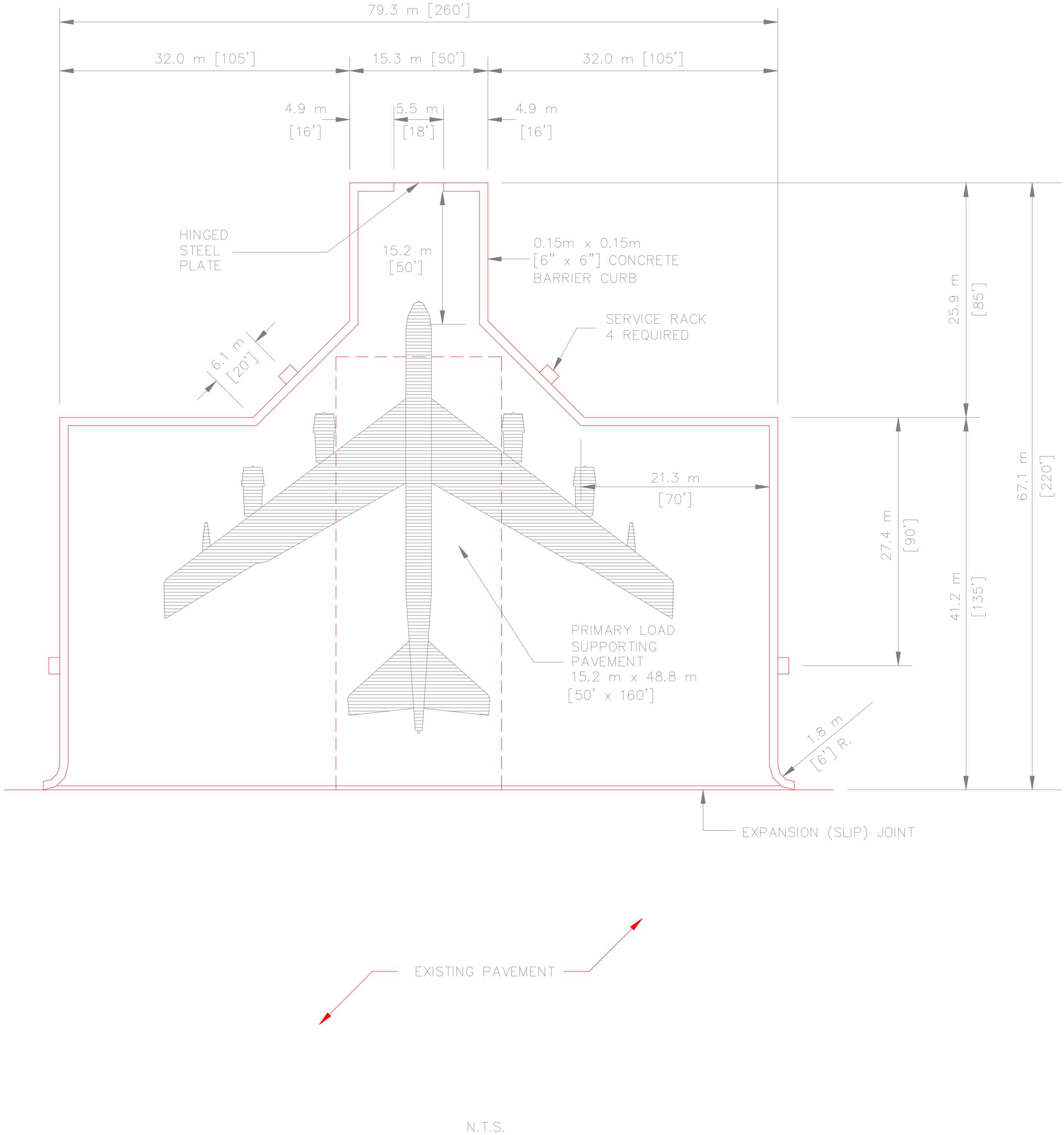


Figure 6.33. Cargo Aircraft Wash Rack.

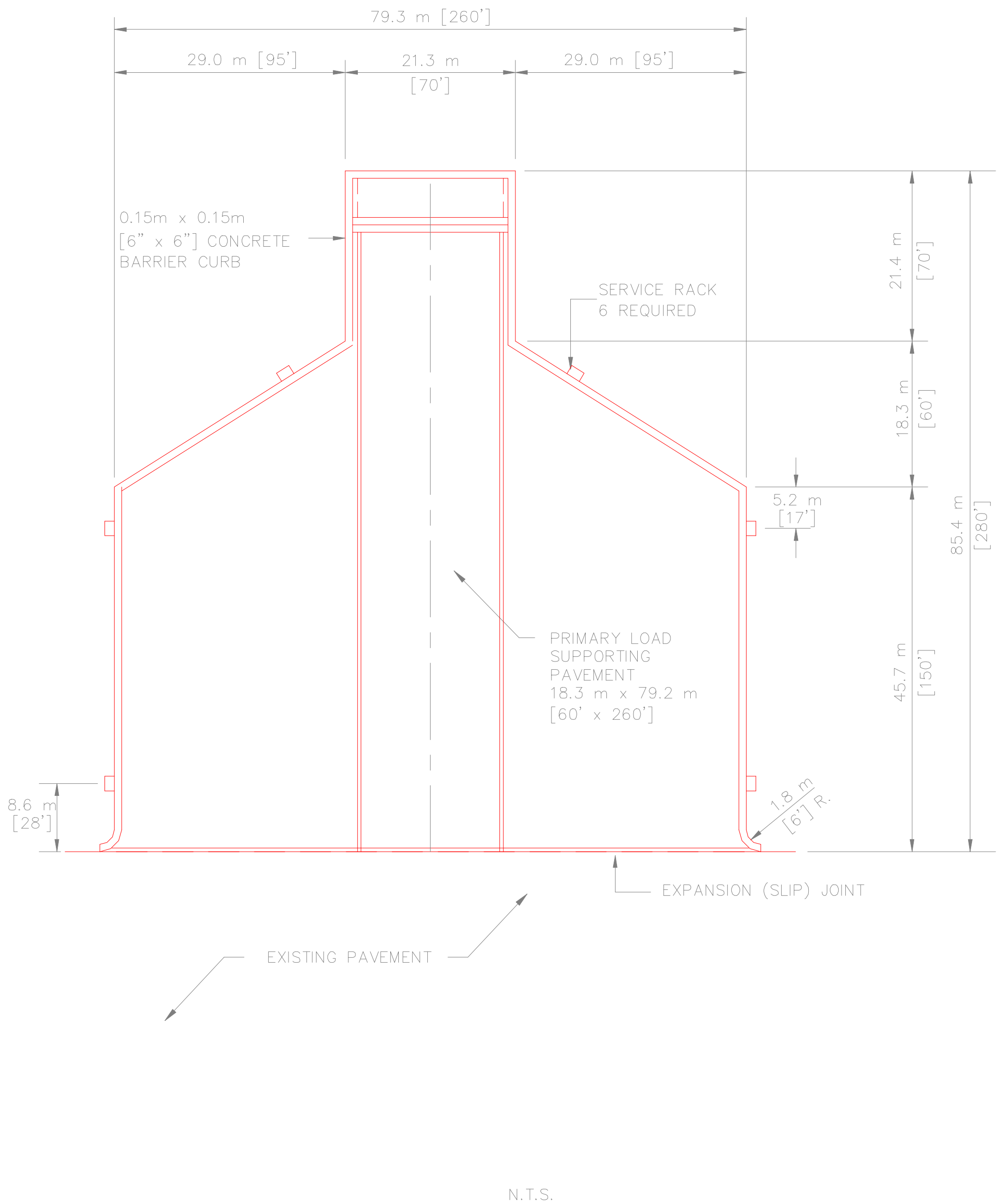


Figure 6.34. Fighter Aircraft Wash Rack and Navy Type A Wash Rack.

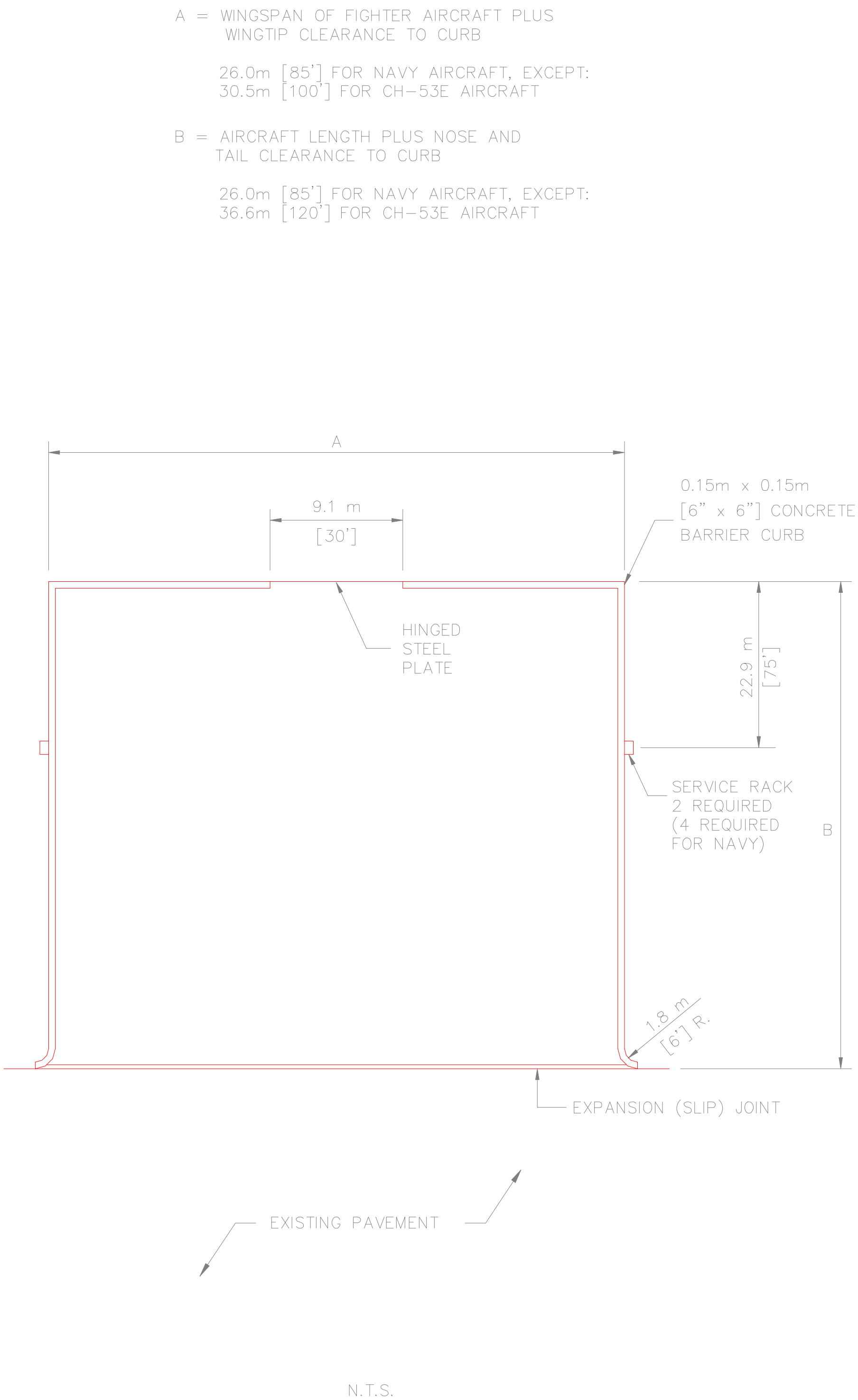


Figure 6.35. Navy Type B Wash Rack.

DIMEN-SION	ALL NAVY AIRCRAFT EXCEPT E-6	E-6 AIRCRAFT
A	42.7m [140']	61m [200']
B	9.2m [30']	10.7m [35']
C	6.1m [20']	4.9m [16']
D	12.2m [40']	29.9m [98']
E	6.1m [20']	10.7m [35']
F	9.1m [30']	4.9m [16']
G	45.8m [150']	57.9m [190']
H	30.5m [100']	45.8m [150']
I	6.1m [20']	4.9m [16']
J	9.2m [30']	7.3m [24']

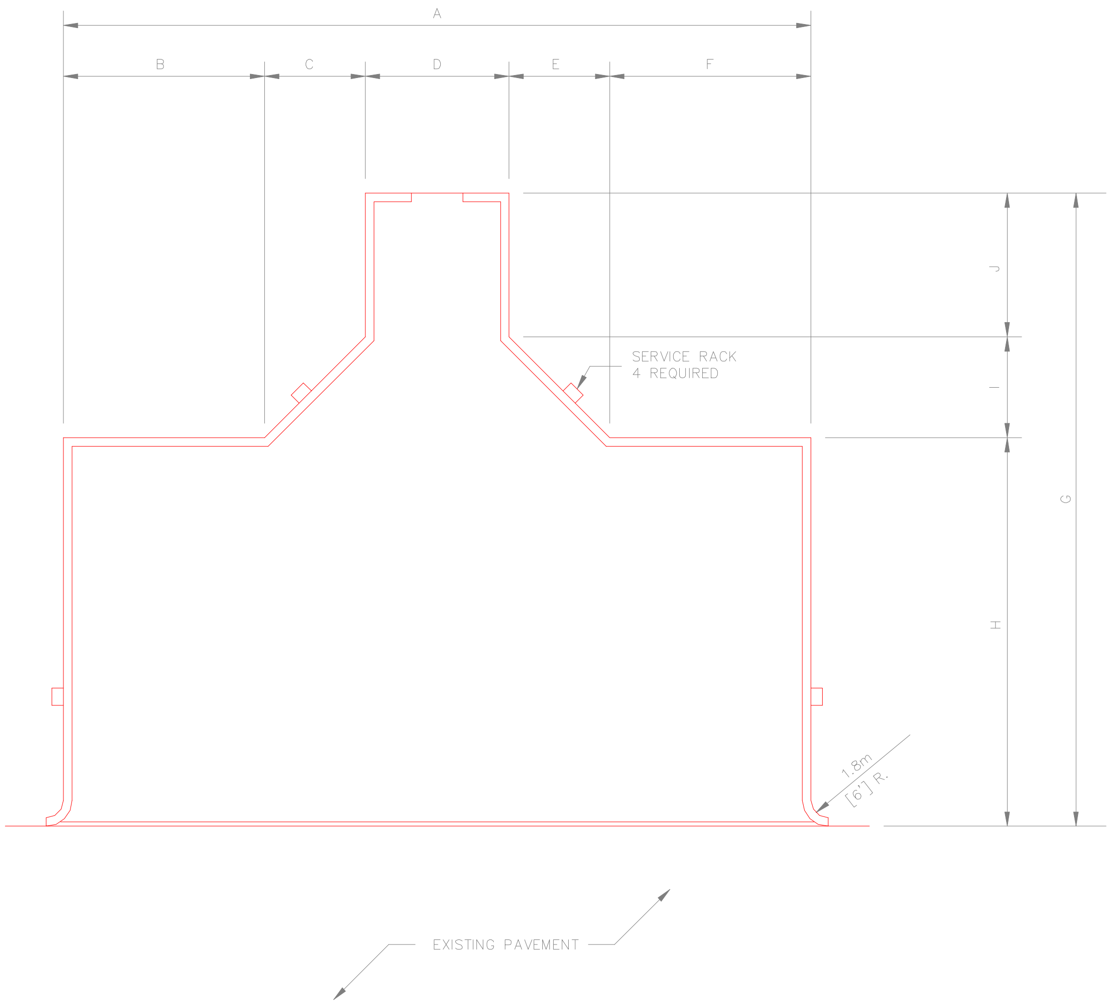


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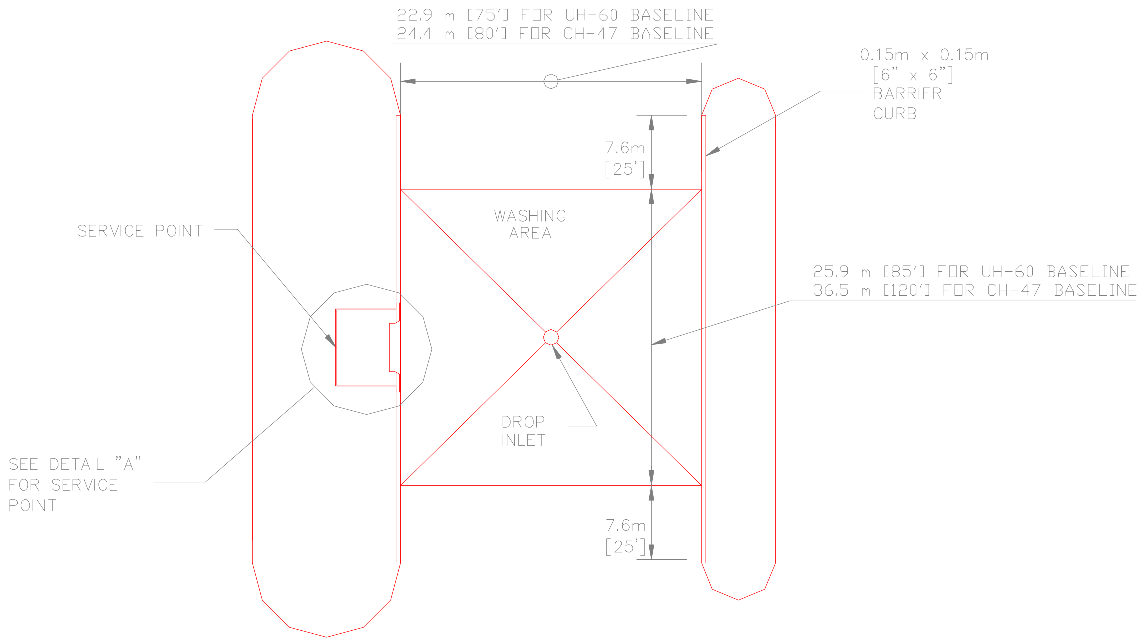
Figure 6.36. Helicopter Wash Rack (Single Helicopter).



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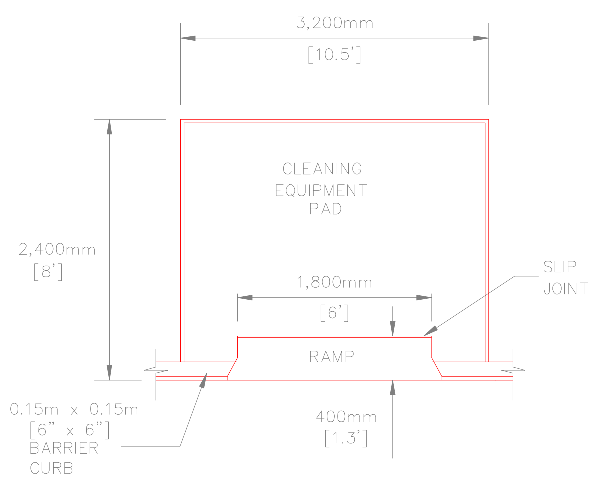


DETAIL A

N.T.S.

6.14.4. Wash Rack Grading. The pavement surface of the wash rack will be sloped at 1.5 percent (1.5%) to assure positive drainage to waste drains.

6.14.5. Tiedowns and Grounding Points. Tiedowns/mooring points/tiedown mooring eyes and grounding points are not required for wash racks.

6.14.6. Concrete Curb. Concrete curbs will be constructed on the perimeter of the wash rack pavement to confine waste water to the wash rack pavement.

6.14.7. Service Points:

6.14.7.1. Army and Air Force. Wash racks are designed with service points incorporated into the pavement floors. These items should be considered for wash rack pavement design. In-pavement structures are listed below. Typical locations for these structures are shown in Figure 6.37.

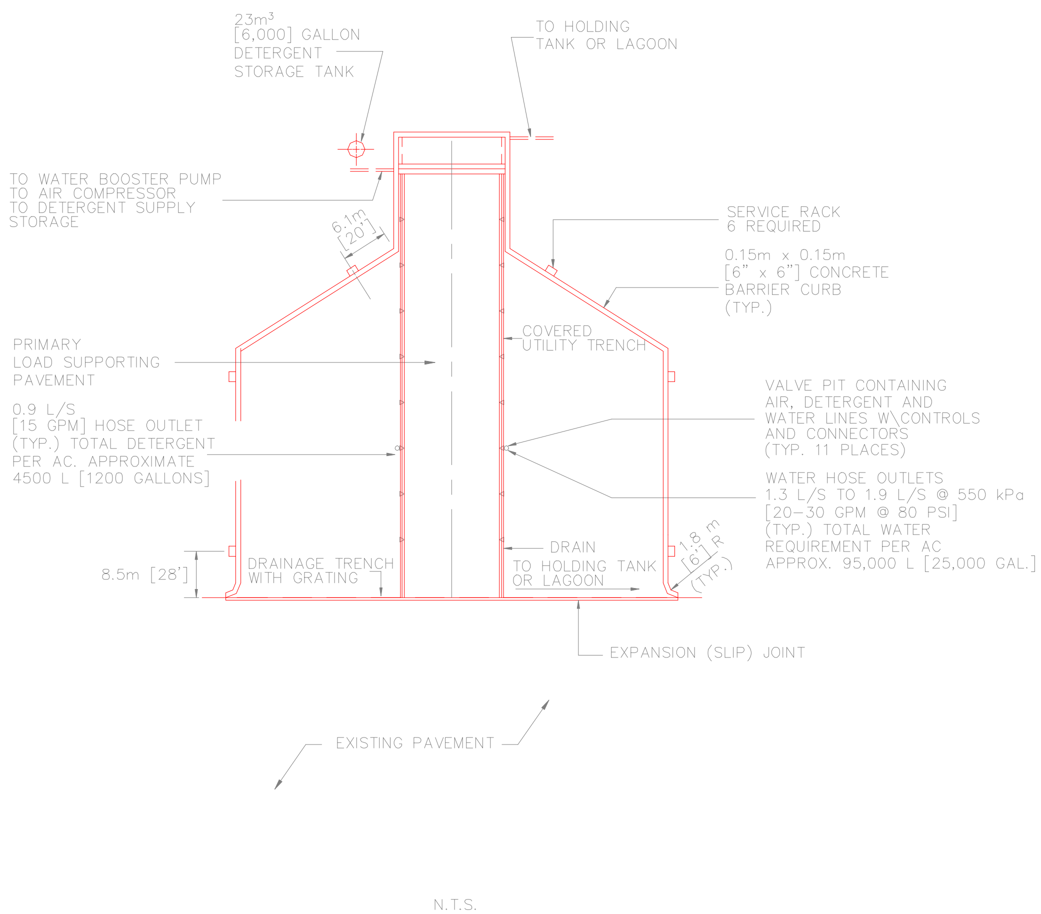
6.14.7.1.1. Valve pits containing air, detergent, and water lines with controls and connectors.

6.14.7.1.2. Water hose outlets.

6.14.7.1.3. Covered utility trench.

6.14.7.1.4. Service Rack.

Figure 6.37. Utilities and In-Pavement Structures.



6.14.7.2. Navy and Marine Corps. Wash rack service points are required for the Navy and Marine Corps.

6.14.8. Wastewater Collection. Waste drains will be located in the center of the wash rack pavement to collect wash water contaminates (oils, alkaline, salts, and hydroxicles) generated from aircraft washing operations. Off-center waste and trench drains are permitted only where necessitated by the aircraft landing gear configuration or where the off-center drains reduce construction costs or suit existing conditions.

6.14.9. Wastewater Treatment. Sewers drain wastewater from waste drains to a 19 cubic meter [5,000 gallon] separator (holding tank). Due to the wash soap, the tanks will not act as oil water separators. Wastewater collection systems will be designed in accordance with AFM 88-11, *Sanitary and Industrial Wastewater Collection Gravity Sewers and Appurtenances,* and MIL-HDBK-1005/9, *Industrial and Oily Wastewater Control*. In no case will untreated waters be discharged directly into the sanitary sewer. Wastewater will be treated in accordance with the requirements of AFM 88-11 and MIL-HDBK-1005/9.

6.14.10. Utility Control Building. Wash racks are supported by an adjacent utilities control building. The building houses detergent make-up equipment, an air compressor, detergent mixing tank, water heater, utility controls, sanitary facilities for personnel, if required, and storage space for cleaning equipment. A detergent storage tank is located outside of the utilities control building and may be below ground. The utility control building should be located far enough from the wash rack to preclude fire hazards associated with heating and electrical equipment. Design of wash rack support facilities is not a part of airfield geometric design and has not been included in this manual.

6.14.11. Utilities. Aircraft wash racks contain utilities which are not normally considered in airfield geometric design; however, the designer may need to be aware that they are an integral part of the wash rack. Design guidance for these utilities has not been included in this manual. All utilities will emanate from the utility control building. These utilities are:

6.14.11.1. Cold water from base supply.

6.14.11.2. Detergent storage tank (often located in the utility building).

6.14.11.3. Compressed air system.

6.14.11.4. Portable hot water generating system (if required).

6.14.11.5. Electrical system.

6.14.11.6. Portable flood lighting, if night wash of aircraft is required.

6.14.11.7. Fire protection, including water supply.

6.15. Hangar Access Aprons. Hangar access aprons provide access to the hangars from the parking apron, and allow free movement of aircraft to the various hangar maintenance facilities. Hangar access aprons should be provided as a supporting item for each authorized hangar and should be sized for the type of hangar and aircraft to be accommodated.

6.15.1. Dimensions. Generally, hangar access aprons should be as wide as the hangar doors and extend from the edge of the apron to the hangar door. Hangar access apron dimension requirements are summarized in Table 6.5.

Table 6.5. Hangar Access Apron.

Item No.	Item Description	Class A Runway Requirement	Class B Runway Requirement	Remarks
1	Length	30 m [100 ft]	40 m [125 ft]	Army facilities for fixed-wing aircraft.
		40 m [125 ft]		Air Force facilities for fixed-wing aircraft.
		23 m [75 ft]		Army and Air Force facilities for rotary-wing aircraft, except as noted below.
		30 m [100 ft]		Army and Air Force facilities for rotary-wing aircraft, regularly servicing H-53 helicopters.
		15 m [50 ft]		Navy and Marine Corps facilities for fixed and rotary-wing aircraft.
		See Remarks		Access aprons are located between the apron and the front of the hangar. The hangar cannot be located within the apron clearance distance except for USAF facilities (see Table 6.1, Item 15).
2	Width	At least as long as the hangar door width.		Pavement should be sized for type of aircraft, number of hangar bays and location of hangar bays.
3	Grades in Direction of Drainage	Min ±0.5% Max ±1.5%		Avoid grades that prevent aircraft tail from clearing hangar doors.
		Min -1.0% first 15 m [50 ft] from hangar		NFPA 415 requires aircraft fueling ramps to slope away from terminal buildings, aircraft hangars, aircraft loading walkways, or other structures.
4	Width of Shoulders (Total Width Including Paved and Unpaved)	7.5 m [25 ft]		
5	Width of Paved Shoulders	Not Required		
6	Sight Distance	NA (See Note 1.)		
7	Transverse Grade of Unpaved Shoulder	(a) 40 mm [1-½"] dropoff at edge of pavement. (b) 5% slope first 3 m [10 ft] from edge of pavement. (c) Beyond 3 m [10 ft] from edge of pavement, 2.0% min, 4.0% max.		

8	Wingtip Clearance to Fixed or Mobile Obstacles	7.6 m [25 ft]	Along length of access apron. Wingtip clearance at entrance to hangar may be reduced to 1.52 m [5 ft].
9	Grade (Area Between Taxiway Shoulder and Taxiway Clearance Line)	Max 10.0% (See note 2.)	

Notes:
1. NA = not applicable
2. Bed of channel may be flat.
3. Metric units apply to new airfield construction and where practical modification to existing airfields and heliports, as discussed in paragraph 1.4.4.
4. The criteria in this manual are based on aircraft specific requirements and are not direct conversions from inch-pound (English) dimensions. Inch-pound units are included only as a reference to the previous standard.
5. Airfield and heliport imaginary surfaces and safe wingtip clearance dimensions are shown as a direct conversion from inch-pound to SI units.

6.15.2. Grades for Aircraft Fueling Ramps. Grades for hangar access ramps on which fueling of aircraft will occur must slope away from aircraft hangars in accordance with National Fire Protection Association (NFPA) Standard 415, *Aircraft Fueling Ramp Drainage*.

6.15.3. Grades for Aircraft Access into Hangars. The grades in front of the hangar must allow access into the hangar. When aircraft are backed into the hangar, a tug vehicle pushes the aircraft in, tail first. Due to the location of the aircraft gear and the slope of the hangar access apron, the tail of the aircraft may be higher than the top of the hangar door. The hangar access apron grades may require adjustment to allow the aircraft tail to clear the hangar door.

6.16. Taxiing Characteristics on Aprons for Rotary-Wing Aircraft:

6.16.1. Hoverlane/Taxilane. Taxi routes across parking aprons are marked to provide safe passage of the aircraft across the apron. A hoverlane is a designated aerial traffic lane used exclusively for the movement of helicopters. A taxilane is a designated ground traffic lane.

6.16.1.1. Army Facilities. At Army Facilities, the hoverlane/taxilane widths are fixed distances, based on type of aircraft, as noted in Table 6.2.

6.16.1.2. Air Force Facilities. At Air Force Facilities, the hoverlane/taxilane width is based on the rotor diameter of the largest helicopter generally using the apron.

6.17. Fixed-Wing and Rotary-Wing Grading Standards:

6.17.1. Fixed-Wing Aircraft. Grading standards for fixed-wing parking aprons and shoulders are presented in Table 6.1. All parking aprons, pads and miscellaneous pavements should follow these grading standards unless a particular mission requirement, such as a power check pad, dictates otherwise. Surface drainage patterns with numerous or abrupt grade changes can produce excessive pavement flexing and structural damage of aircraft and should be avoided.

6.17.2. Rotary-Wing Aircraft. Grading standards for rotary-wing parking aprons are presented in Table 6.2 for Army facilities and AFH 32-1084, *Standard Facility Requirements Handbook* for Air Force facilities.

6.17.3. Grades for Aircraft Fueling Ramps. Grades for ramps on which fueling of aircraft will occur should be in accordance with National Fire Protection Association (NFPA) Standard 415, *Aircraft Fueling Ramp Drainage*.

6.18. Shoulders. Paved shoulders are provided around the perimeter of an apron to protect against jet blast and FOD, to support blast deflectors, for support equipment storage, and to facilitate drainage. Criteria for apron shoulders are presented in Table 6.1 for fixed-wing aprons, Table 6.2 for Army rotary-wing aprons, and AFH 32-1084 for Air Force rotary-wing facilities. To prevent storm water from ponding on the outside edge of the shoulder, the turf adjacent to the paved shoulder should be graded to facilitate drainage.

6.19. Miscellaneous Apron Design Considerations. In addition to the apron design criteria, consideration should be given to providing room for support structures, equipment, and facilities.

6.19.1. Jet Blast Deflectors. Jet blast deflectors will substantially reduce the damaging effects of jet blast on structures, equipment, and personnel, as well as the related noise and fumes associated with jet engine operation. Additional information on jet blast deflectors is found in Attachment 9.

6.19.2. Line Vehicle Parking. Line vehicle parking areas are provided for parking of mobile station-assigned and squadron-assigned vehicles and equipment. Additional information on line vehicle parking is found in Attachment 13.

6.19.3. Utilities. The following items are normally found on parking aprons. These items are not a part of airfield geometric design. However, the designer needs to be aware that they are an integral part of a parking apron and should make provisions for them accordingly.

6.19.3.1. Storm water runoff collection system including inlets, trench drains, manholes, and pipe.

6.19.3.2. De-icing facilities and de-icing runoff collection facilities.

6.19.3.3. Apron illumination.

6.19.3.4. Fire hydrants.

6.19.3.5. Refueling facilities.

6.19.3.6. Apron edge lighting.

6.20. Jacking Considerations. Cribbing is required during jacking of aircraft on aprons during maintenance procedures. Supporting aircraft on jacks without cribbing can create stresses that exceed that which apron pavements were designed to support and can cause pavement failure. Aprons and hangar floors should not be designed to resist jacking forces applied without cribbing.

Chapter 7

SHORTFIELDS AND TRAINING ASSAULT LANDING ZONES

7.1. RESERVED FOR FUTURE USE

Chapter 8

AIRCRAFT HANGAR PAVEMENTS

8.1. General Requirements. Hangars provide space for various aircraft activities: scheduled inspections; landing gear tests; weighing of aircraft; major work and maintenance of fuel systems and airframes; and technical order compliance and modifications. These activities can be more effectively accomplished while the aircraft is under complete cover. Pavement for hangar floors must be designed to support aircraft loads. Hangars provide covered floor space to accommodate aircraft. Clearance must be provided between the aircraft and the door opening, walls, and ceiling of the hangar. This chapter does not apply to the Navy and Marine Corps other than to provide applicable Navy publications where additional information may be found.

8.2. Aircraft Modules Space. Table 8.1 presents the dimensions and sizes of modules for various Army aircraft. These modules are used to determine hangar size.

Table 8.1. Aircraft Space Module for Army Aviation Facilities.*

	Dimension					
	Length		Width		Module	
Type of Aircraft**	Meters	Feet	Meters	Feet	Square Meters	Square Feet
UH-1, AH-1, OH-58 (2 Blades)	23.5	77	9.1	30	215	2,310
UH-1 (4 Blades)	23.5	77	16.5	54	386	4,158
UH-60 (4 Blades)	25.6	84	19.5	64	499	5,376
AH-64 (4 Blades)	23.5	77	18.3	60	429	4,620
OH-58 (4 Blades)	23.5	77	13.7	45	322	3,465
CH-47 (6 Blades Tandem)	33.5	110	21.3	70	715	7,700
C-12 Fixed Wing	19.5	64	19.8	65	386	4,160

* Aircraft space modules shown in the table have been derived by adding approximately 6 meters [20 feet] to the aircraft width and length dimensions, thus providing a 3-meter [10-foot] wide buffer/work space around each aircraft.

** Equate aircraft such as U-6, U-8, and U-21 to C-12; equate C-23 to C-12; equate AH-1S to UH-1 (4 blades).

NOTE: Metric units apply to new airfield construction, and where practical, modifications to existing airfields and heliports, as discussed in paragraph 1.4.4.

8.3. Hangar and Shelter Clearances. The interior design of covered shelters must include the clearances between aircraft and door opening, walls, and ceiling, and also parking clearances between other aircraft. These clearances are essential to ensure aircraft are protected aircraft from structural damage. The clearances allow personnel to maneuver more easily during aircraft maintenance. Hangar and alert/hardened shelter clearance information is presented in Table 8.2.

8.4. Hangar Floor Design. Hangar floors will be designed as pavements in accordance with TM 5-825-3 for Army, AFJMAN 32-1014 for Air Force, and MIL-HDBK 1028-1A for Navy, and constructed of rigid pavement. Hangar floors must be designed for cribbing. Jacks must not be used to lift and support aircraft; therefore, designs incorporating the use of jacks must not be used in the design analysis. Signs will be posted in hangars to inform personnel on the use of cribbing.

Table 8.2. Aircraft Clearances Inside Hangars. (See note 1.)

Aircraft Element		Minimum Clearances from Hangar Elements					
		Door		Walls		Roof Framing (See note 2.)	
		Meters	Feet	Meters	Feet	Meters	Feet
Wingtip	Under 30 m [100 ft] span	3	10	3	10	--	--
Fuselage	Under 30 m [100 ft] span	3	10	3	10	3	10
Wingtip	Over 30 m [100 ft] span	3	10	4.5	15	--	--
Fuselage	Over 30 m [100 ft] span	3	10	4.5	15	3	10
Tail	Vertical	2	7	--	--	3	10
Tail	Horizontal	3	10	3	10	3	10

Notes:
1. Clearances between aircraft components should be at least 3 meters [10 feet] where two or more aircraft are housed. None of the above clearances requires a waiver for existing facilities. The above clearance data are also applicable to alert and hardened aircraft shelters.
2. Clearance over aircraft when pulled into a hangar.

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Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

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AFI 13-209, *Instrument Procedures*

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Abbreviations and Acronyms

AC—advisory circular

a.c.—alternating current

AFCESA—Air Force Civil Engineer Support Agency

AFFSA—Air Force Flight Standards Agency

AFH—Air Force Handbook

AFI—Air Force Instruction

AFJMAN—Air Force Joint Manual

AFJPAM—Air Force Joint Pamphlet

AFM—Air Force Manual

AFMAN—Air Force Manual

AFPD—Air Force Policy Directive

AFR—Air Force Regulation

AICUZ—Air Installation Compatibility Use Zone

ALSF1—High Intensity ALS with Sequenced Flashing Lights

ALSF2—High Intensity ALS with Sequenced Flashing Lights

ALS—Approach Lighting System

AMSL—above mean sea level

ANG—Air National Guard

APOE—Aerial Ports of Embarkation

APOD—Aerial Ports of Debarkation

APZ I—Accident Potential Zone I

APZ II—Accident Potential Zone II

AR—Army Regulation

ASOS—Automatic Surface Observation Station

ASR—Airport Surveillance Radar

ASV—Annual Service Volume

ATC—Air Traffic Control

ATCALS—Air Traffic Control and Landing Systems

ATCT—Air Traffic Control Tower

AVGAS—aviation gasoline

AVIM—Aviation Intermediate Maintenance

AVUM—Aviation Unit Maintenance

AWOS—Automated Weather Observation Station

BAK—Barrier, Arresting Kit

CAT I ILS—Category I Instrument Landing System

CAT II ILS—Category II Instrument Landing System

CCP—Compass Calibration Pad

CoE—Corps of Engineers

COE TSMCX—Corps of Engineers Transportation Systems Mandatory Center of Expertise

CX—categorical exclusion

DA—Department of the Army

DA PAM—Department of the Army Pamphlet

d.c.—direct current

DH—decision height

DIA—diameter

DM—Design Manual

DME—Distance Measuring Equipment

DoD—Department of Defense

EA—Environmental Assessment

EED—Electroexplosive Device

EIS—Environmental Impact Statement

EMI—electromagnetic interference

ES—explosive sites

ETL—Engineering Technical Letter

FAA—Federal Aviation Administration

FM—Field Manual (US Army)

FONSI—Finding of No Significant Impact

FOD—foreign object damage

FSSZ—Fuel Servicing Safety Zone

GCA—Ground Control Approach

GPI—Ground Point of Intercept

GPS—Global Positioning System

HIRL—High Intensity Runway Edge Lights

HNM—Helicopter Noise Model

ICAO—International Civil Aviation Organization

ICUZ—Installation Compatible Use Zone

IEEE—Institute of Electrical and Electronic Engineers

IES—Illuminating Engineering Society of North America

IFR—Instrument Flight Rules

ILS—Instrument Landing System

IM—Inner Marker

IMC—Instrument Meteorological Conditions

LANTDIV—Atlantic Division of the Naval Facilities Engineering Command

LDIN—Leadin Lighting System

MACOM—Major Command (US Army)

MAJCOM—Major Command (USAF)

MALS—Medium Intensity Approach Lighting System

MALSF—Medium Approach Light System with Sequenced Flashers

MALSR—Medium Approach Light System with Runway Alignment Indicator Lights

MATCT—Mobile Air Traffic Control Tower

max—maximum

MDA—Minimum Descent Altitude

METNAV—Meteorological NAVAIDS Detachment

MILHDBK—Military Handbook

min—minimum

MIRL—Medium Intensity Runway Edge Lights

MLS—Microwave Landing System

MM—Middle Marker

MMLS—Mobile Microwave Landing System

MSL—mean sea level

MTI—Moving Target Indicator

NA—not applicable

NAD83—North American Datum of 1983

NATO—North Atlantic Treaty Organization

NAVAID or NavAIDS—Navigational Aids

NAVAIR—Naval Air Systems Command

NAVFAC—Naval Facilities Engineering Command

NAVFACINST—Naval Facilities Engineering Command Instruction

NAVFAC P—Naval Facilities Engineering Command Publication

NAVFACENGCOM—Naval Facilities Engineering Command

NAVFIG—Naval Flight Information Group

NAVSEA OP—Naval Sea Operations Command Operating Instruction

NDB—non directional beacon

NEPA—National Environmental Policy Act

NFPA—National Fire Protection Association

NM—nautical mile (1,852 m) (6,076 feet)

NTS—not to scale

ODALS—Omnidirectional Approach Lighting System

OLS—Optical Landing System

OM—outer marker

OPNAVINST—Operations Naval Instruction

PAPI—Precision Approach Path Indicator

PAR—Precision Approach Radar

PES—Potential Explosive Site

PI—Point of Intersection

Q-D—QuantityDistance

RAIL—Runway Alignment Indicator Lights

RAPCON—Radar Approach Control

REIL—Runway End Identifier Lights

RF—Radio Frequency

ROD—Record of Decision

RSU—Runway Supervisory Unit

RSZ—Refueling Safety Zone

RVR—Runway Visual Range

RWOS—Representative Weather Observation Station

SALS—Short Approach Lighting System

SFA—Support Facility Annexes

SM—statute mile (1,609 m) (5,280 feet)

SOI—Statement of Intent

SPR—Single Point Receptacle

SSALR—Simplified Short Approach Light System with Runway Alignment Indicator Lights

STANAG—Standardization Agreement

TACAN—Tactical Air Navigation

TCH—Threshold Crossing Height

TERPS—Terminal Instrument Procedures

TM—Technical Manual

TOE—Tables of Organization and Equipment

TVOR—Terminal Very High Frequency Omnidirectional Range

USAASA—US Army Aeronautical Services Agency

USAATCA—US Army Air Traffic Control Activity

USAF—United States Air Force

VASI—Visual Approach Slope Indicator

VIP—Very Important Person

VFR—Visual Flight Rules

VMC—Visual Meteorological Conditions

VOR—Very High Frequency Omnidirectional Range (Radio)

VORTAC—Very High Frequency Omnidirectional Range (Radio) and Tactical Air Navigation

VSTOL—Vertical Short Takeoff and Landing

VTOL—Vertical Takeoff and Landing

WGS84—World Geodetic System 1984

Terms

Aborted Takeoff—An unsuccessful takeoff operation due to power or other mechanical failures.

Accident Potential Zone I (APZ I)—The area beyond the clear zone that possesses a significant potential for accidents.

Accident Potential Zone II (APZ II)—The area beyond APZ I that has a measurable potential for accidents.

AICUZ (Air Installation Compatible Use Zone)—A DoD program designed to promote compatible development around military airfields and to protect the integrity of the installation's flying mission.

Air Traffic—Aircraft in operation anywhere in the airspace and within that area of an airfield or airport normally used for the movement of aircraft.

Aircraft—Fixed-wing (F/W) (Airplane) and rotary-wing (R/W) (helicopter).

Aircraft, Class A—Aircraft listed under Class A Runways in Table 3.1 of this manual.

Aircraft, Class B—Aircraft listed under Class B Runways in Table 3.1 of this manual.

Aircraft Arresting Barrier—A device, not dependent on an aircraft hook, used to engage and absorb the forward momentum of an emergency landing or an aborted takeoff.

Aircraft Arresting Cable—That part of an aircraft arresting system which spans the runway surface or flight deck landing area and is engaged by the aircraft arresting gear.

Aircraft Arresting Complex—An airfield layout comprised of one or more arresting systems.

Aircraft Arresting Gear—A device used to engage hook-equipped aircraft to absorb the forward momentum of a routine or emergency landing or aborted takeoff.

Aircraft Arresting System—A series of components used to engage and absorb the forward momentum of a routine or emergency landing or an aborted takeoff.

Aircraft Wash Area—A specially designed paved area for washing and cleaning aircraft.

Aircraft Wash Rack—Paved areas provided at all facilities to clean aircraft in conjunction with periodic maintenance.

Aircraft Rinse Facility—Paved areas provided at facilities to clean aircraft returning from flight and en route to the parking area.

Airfield—An area prepared for the accommodation (including any buildings, installations, and equipment), of landing and takeoff of aircraft.

Airfield Elevation—The established elevation, in terms of the nearest 300 mm (one foot) above mean sea level, of the highest point of the usable landing area.

Airfield Reference Point—The designated geographical location of an airfield. It is given in terms of the nearest second of latitude and longitude. The position of the reference point must be as near to the geometric center of the landing area as possible, taking future development of the airfield into account.

Airport—Refers to a civil or municipal airfield.

Airside Facilities—Facilities associated with the movement and parking of aircraft. These include runways, taxiways, apron areas, associated navigational aids and imaginary surfaces.

Airspace—The space above ground or water areas which is or is not controlled, assigned, and/or designated.

Alert Aircraft Parking—An exclusive paved area for armed aircraft to park and have immediate, unimpeded access to a runway.

Alert Pad—Small paved areas provided for single alert aircraft parking.

Approach Control—A service established to control flights, operating under instrument flight rules (IFR), arriving at, departing from, and operating in the vicinity of airports by direct communication between approach control personnel and aircraft operating under their control.

Approach-Departure Clearance Surface—An inclined plane or combined inclined and horizontal planes arranged symmetrically about the runway centerline extended. The first segment or the beginning of the inclined plane is coincident with the ends and edges of the primary surface, and the elevation of the centerline at the runway end. This surface flares outward and upward from these points.

Apron—A defined area, on an airfield, intended to accommodate aircraft for the purposes of loading or unloading passengers or cargo, refueling, parking or maintenance.

Apron, Aircraft Access—See Apron, Hangar Access.

Apron, Alert—A designated area for multiple alert aircraft parking.

Apron Edge—See Edge of Apron.

Apron, Hangar Access—Hangar access aprons are paved areas connecting hangars with adjacent aircraft aprons.

Apron, Holding (Engine Run up Area)—A paved area adjacent to the taxiway near the runway ends where final preflight warmup and engine and instrument checks are performed.

Apron, Parking—A parking apron is a designated paved area on an airfield intended to accommodate fixed-and rotary-wing aircraft for parking.

Arming and Disarming—The loading and unloading of missiles, rockets, and ammunition in aircraft.

Arrestment Capable Aircraft—An aircraft whose flight manual specifies arrestment procedures.

Autorotation Lane—A helicopter landing lane or designated area on a runway used for practicing landings under simulated engine failure or certain other emergency conditions. Also known as a slide area when designed specifically for USAF skid-type helicopters.

Aviation Facility—The combination of land, airspace, pavements and buildings which are needed to support an aviation movement or action. An aviation facility can be an airfield, heliport, or helipad. The aviation facility includes “airside” and “landside” facilities.

Aviation Intermediate Maintenance (AVIM)—For Army, units that provide mobile, responsive "one-stop" maintenance and repair of equipment to return to user.

Aviation Movement or Action—An aviation movement or action includes but is not limited to: the landing and take-off of aircraft; readiness of aircraft; flight training of pilots; loading and unloading of aircraft; and the maintenance and fueling of aircraft.

Aviation Unit Maintenance (AVUM)—For Army, activities staffed and equipped to perform high frequency "on aircraft" maintenance tasks required to retain or return aircraft to a serviceable condition.

Avigation Easement—A legal right obtained from a property owner to operate aircraft over that property and to restrict the height of any construction or growth on that property.

Beam Wind Component—The wind velocities perpendicular to the axis of the runway centerline used to measure the degree by which a runway pattern covers incident wind.

Blast Protective Area—An area protected by pavement construction at the ends of runways and taxiways against jet blast erosion.

Circling Approach Area—The area in which aircraft circle to land under visual conditions.

Clear Zone—A surface on the ground or water beginning at the runway end and symmetrical about the runway centerline extended.

Compass Calibration Pad—An aircraft compass calibration pad is a paved area in an electromagnetically quiet zone where an aircraft's compass is calibrated.

Compass Rose—A graduated circle, usually marked in degrees, indicating directions and printed or inscribed on an appropriate medium.

Conical Surface—An imaginary surface that extends from the periphery of the inner horizontal surface outward and upward at a slope of 20 horizontal to one for a horizontal distance of 2,133.6 m (7,000 ft) to a height, 152.4 m (500 ft) above the established airfield elevation. The conical surface connects the inner horizontal surface with the outer horizontal surface. It applies to fixed-wing installations only.

Controlling Obstacle—The highest obstacle relative to a prescribed plane within a specified area. In precision and non-precision approach procedures where obstacles penetrate the approach surface, the controlling obstacle is the one which results in the requirement for the highest Decision Height (DH) or Minimum Descent Altitude (MDA).

Crosswind Runway—A secondary runway that is required when the primary runway orientation does not meet crosswind criteria (see Appendix D).

Decision Height—A height above the highest elevation in the touchdown zone, specified for a precision approach, at which a missed approach procedure must be initiated if the required visual reference has not been established.

Displaced Threshold—A runway threshold that is not at the beginning of the full-strength runway pavement.

Edge of Apron—The boundary of an apron, marked by painted stripe in accordance with pavement marking manual.

Fixed-Wing Aircraft—A powered aircraft that has wings attached to the fuselage so that they are either rigidly fixed or swing-wing, as distinguished from aircraft with rotating wings, like a helicopter.

Flight Path—The line connecting the successive positions occupied, or to be occupied, by an aircraft, missile, or space vehicle as it moves through air or space.

Fuel Servicing Safety Zone (FSSZ)—The FSSZ is the area required for safety around pressurized fuel carrying servicing components; i.e. servicing hose, fuel nozzle, single point receptacle (SPR), hydrant hose car, ramp hydrant connection point, etc. and around aircraft fuel vent outlets. The fuel servicing safety zone is established and maintained during pressurization and movement of fuel.

Full Stop Landing—The touchdown, rollout, and complete stopping of an aircraft to zero speed on runway pavement.

Grade—Also Gradient—A slope expressed in percent. For example, a 0.5 percent grade means a 0.5 meter [foot] slope in 100 meters [feet].

Ground Point of Intercept (GPI)—A point in the vertical plane of the runway centerline or center of a helipad at which it is assumed that the straight line extension of the glide slope (flight path) intercepts the approach surface base line (TM 95-226).

Hardstand—See Apron.

Helicopter—An aircraft deriving primarily elements of aerodynamic lift, thrust and control from one or more power driven rotors rotating on a substantially vertical axis.

Helicopter(Small)—OH, UH and AH helicopters with a gross weight of 5,670 kg [12,500 pounds] or less.

Helicopter Parking Space, Type 1 (Army Only)—In this configuration, rotary-wing aircraft are parked in a single lane, which is perpendicular to the taxilane.

Helicopter Parking Space, Type 2 (Army Only)—In this configuration, rotary-wing aircraft are parked in a double lane, which is parallel to the taxilane.

Helicopter Runway—A prepared surface used for the landing and takeoff of helicopters requiring a ground run.

Helipad—A prepared area designated and used for takeoff and landing of helicopters (includes touchdown and hoverpoint.)

Heliport—A facility designed for the exclusive operating, basing, servicing and maintaining of rotary-wing aircraft (helicopters). The facility may contain a rotary-wing runway and/or helipads.

Heliport or Helipad Elevation—The established elevation, in terms of the nearest 300 mm (one foot) above mean sea level, based on the highest point of the usable landing area.

High-Speed Taxiway Turnoff—A taxiway leading from a runway at an angle which allows landing aircraft to leave a runway at a high speed.

Holding Position—A specified location on the airfield, close to the active runway and identified by visual means, at which the position of a taxiing aircraft is maintained in accordance with air traffic control instructions.

Horizontal Surfaces, Fixed-Wing:

Inner Horizontal Surface—An imaginary plane 45.72 m (150 ft) above the established airfield elevation. The inner boundary intersects with the approach-departure clearance surface and the transitional surface. The outer boundary is formed by scribing arcs with a radius 2,286.0 m (7,500 ft) from the centerline of each runway end, and interconnecting those arcs with tangents.

Outer Horizontal Surface**—**An imaginary plane 152.4 m (500 ft) above the established airfield elevation extending outward from the outer periphery of the conical surface for a horizontal distance of 9,144.0 m (30,000 ft).

Horizontal Surface, Rotary-Wing—An imaginary plane at 45.72 m (150 ft) above the established heliport or helipad elevation. The inner boundary intersects with the approach-departure clearance surface and the transitional surface. The outer boundary is formed by scribing an arc with a radius of 1,402 m (4,600 ft) at the end of each runway, and connecting the arcs with tangents, or by scribing the arc about the center of the helipad.

Hover—A term applied to helicopter flight when the aircraft: (1) maintains a constant position over a selected point (1 m to 3 m [3 ft to 10 ft] above ground), and (2) is taxiing (airborne) (1 m to 3 m [3 ft to 10 ft] above ground) from one point to another.

Hoverlane—A designated aerial traffic lane for the directed movement of helicopters between a helipad or hoverpoint and the servicing and parking areas of the heliport or airfield.

Hoverpoint—A prepared and marked surface at a heliport or airfield used as a reference or central point for arriving or departing helicopters.

IFR Helipad—A helipad designed for Instrument Flight Rules. IFR design standards are used when an instrument approach capability is essential to the mission and no other instrument landing facilities, either fixed-wing or rotary-wing, are located within an acceptable commuting distance to the site.

Imaginary Surfaces. Surfaces in space established around airfields in relation to runway(s), helipad(s), or helicopter runway(s) that are designed to define the obstacle free airspace around the airfield. The imaginary surfaces for DoD airfields are the primary surface, the approach-departure clearance surface, the transitional surface, the inner horizontal surface, the conical surface (fixed-wing only), and the outer horizontal surface (fixed-wing only).

Ingress/Egress, Same Direction—One approach-departure route to and from the helipad exists. The direction from which the rotary-wing aircraft approaches the helipad (ingress) is the only direction which the rotary-wing aircraft departs (egress) from the helipad. Typically, the helipad is surrounded by obstacles on three sides which make approaches from other directions impossible. For example, if the rotary-wing aircraft approaches from the southwest, it must also depart to the southwest.

Ingress/Egress, Two Direction—Rotary-wing aircraft can approach and depart the helipad from two directions (one direction and the opposite direction). (See also Ingress/Egress, Same Direction.)

Instrument Runway—A runway equipped with electronic navigation aids for which a precision or non-precision approach procedure is approved.

Instrument Flight Rules (IFR)—Rules that govern the procedure for conducting instrument flight. Also see Instrument Meteorological Conditions.

Instrument Landing System—A system of ground equipment designed to provide an approach path for exact alignment and descent of an aircraft on final approach to a runway. The ground equipment consists of two highly directional transmitting systems and, along the approach, three (or fewer) marker beacons. The directional transmitters are known as the localizer and glide slope transmitters.

Instrument Meteorological Conditions—Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling; less than minimums specified for visual meteorological conditions.

Intermediate Area—The area between runways and between runways and taxiways that is graded or cleared for operational safety.

Joint/Shared Use Airfield—Those airports that are shared by a civilian DoD agency covered under the "Airports and Airway Improvement ACT of 1982 (Public LAW 97-248, Sep 3, 1982, 49 USC, APP 2201.) Only those facilities (i.e., runways/taxiways) that are used by both civilian and DoD agencies are considered "Shared/Joint Use." All other facilities (parking ramps, hangars, terminals, and so forth) are the sole property of the using agency. A US Air Force installation where agreements exist among the Air Force, civil, and host nation authorities for joint use of all or a portion of airfield facilities.

Landing Area—See Take-Off and Landing Area.

Landing Field—Any area of land consisting of one or more landing strips, including the intermediate area, that is designed for the safe takeoff and landing of aircraft.

Landing Lane—A defined lane on the airfield used for simultaneous takeoff and landings of multiple (up to four at one time) helicopters. Landing lanes are used at airfields or heliports when a high density of helicopters are parked on an apron, or in the process of takeoff and landings.

Landing Rollout—Distances covered in stopping the aircraft, when loaded to maximum landing weight, following touchdown using standard operation and braking procedures on a hard, dry-surfaced, level runway with no wind.

Landing Strip—That portion of an airfield that includes the landing area, the end zones, and the shoulder areas. Also known as a flight strip.

Landside Facilities—Landside facilities are facilities not associated with the movement and parking of aircraft but are required for the facilities' mission. These include aircraft maintenance areas, aviation support areas, fuel storage and dispensing, explosives and munitions areas and vehicular needs.

Large Transport Aircraft—A transport aircraft with a wing span of 33.5 m [110 ft] or greater.

Light Bar—A set of lights arranged in a row perpendicular to the light system centerline.

Limited Use Helipad—Helipad, limited to small helicopters 5,670 kg (12,500 lbs) or less, for low density VFR operations only, i.e., occasional operations at special locations such as hospitals or involving only small helicopters (OH, UH, AH type).

Line Vehicle—Any vehicle used on the landing strip, such as a crash fire truck or tow tractor.

Localizer—A directional radio beacon which provides to an aircraft an indication of its lateral position relative to a predetermined final approach course.

Localizer Type Directional Aid (LDA)—A NAVAID used for nonprecision instrument approaches with utility and accuracy comparable to a localizer but which is not part of a complete ILS. The LDA is not aligned with the runway, but may be aligned within 3 degrees (3°) of the runway centerline.

Magnetic North—The direction indicated by the north-seeking pole of a freely suspended magnetic needle, influenced only by the earth's magnetic field.

Magnetic Variation—At a given place and time, the horizontal angle between the true north and magnetic north measured east or west according to whether magnetic north lies east or west of true north.

Magnetically Quiet Zone—A location where magnetic equipment, such as a compass, is only affected by the earth's magnetic forces.

Non-Precision Approach—An approach flown by reference to electronic navigation aids in which glide slope information is not available.

Non-Instrument Runway—A runway intended for operating aircraft that under visual flight rules.

Obstacle—An existing object, natural growth, or terrain, at a fixed geographical location, or which may be expected at a fixed location within a prescribed area, with reference to which vertical clearance is or must be provided during flight operations.

Obstacle Clearance—The vertical distance between the lowest authorized flight altitude and a prescribed surface within a specified area.

Obstruction—A natural or man-made object that violates airfield or heliport clearances, or projects into imaginary airspace surfaces. Navy and Marine Corps see NAVFAC P-80.3.

Overrun Area—An area the width of the runway plus paved shoulders extending from the end of the runway to the outer limit of the end zone. This portion is a prolongation of the runway which is the stabilized area.

Parking, Aircraft Undergoing Maintenance—Apron parking space is provided for parking aircraft which must undergo maintenance.

Parking, Alert Aircraft—Parking for aircraft that must be in flight upon short notice.

Parking, Operational Aircraft—Parking for operational aircraft assigned to a particular installation.

Parking, Transient Aircraft—Parking for transient aircraft (non-operational) at the installation, but not assigned there.

Parking, Transport Aircraft—Parking for transport aircraft carrying cargo and personnel which must be loaded and unloaded.

Pavement (Paved Surface)—A durable weather and abrasion resistant surface made from a prepared or manufactured material placed on an established base. General categories of pavements are flexible and rigid.

Power Check—The full power test of an aircraft engine while the aircraft is held stationary.

Power Check Pad—An aircraft power check pad is a paved area, with an anchor block in the center, used to perform full-power engine diagnostic testing of aircraft engines while the aircraft is held stationary.

Precision Approach—An approach in which azimuth and glide slope information are provided to the pilot.

Primary Surface (Fixed-Wing Runways)—An imaginary surface symmetrically centered on the runway, extending 60.96 m (200 ft) beyond each runway end. The width varies depending upon the class of runway and coincides with the lateral clearance distance. The elevation of any point on the primary surface is the same as the elevation of the nearest point on the runway centerline.

Primary Surface (Rotary-Wing Runways and Landing Lanes)—An imaginary surface symmetrically centered on the runway, extending beyond the runway ends. The width and length depends upon whether the runway/landing lane is to accommodate VFR or IFR operations. The lateral clearance distance coincides with the width of the primary surface. The elevation of any point on the primary surface is the same as the elevation of the nearest point on the runway centerline.

Runway—A defined rectangular area of an airfield or heliport prepared for the landing and takeoff run of aircraft along its length.

Runway (Class A)—Class A runways are primarily intended for small light aircraft. Ordinarily, these runways have less than 10 percent of their operations involving aircraft in the Class B category. These runways are normally less than 2,440 m (8,000 ft).

Runway (Class B)—Class B runways are all fixed-wing runways that accommodate normal operations of Class B Aircraft.

Runway End—As used in this manual, the runway end is where the normal threshold is located. When the runway has a displaced threshold, the using service will evaluate each individual situation and, based on this evaluation, will determine the point of beginning for runway and airspace imaginary surfaces.

Runway Exit—A taxiway pavement provided for turnoffs from the runway to a taxiway either at normal or high speed.

Runway, Parallel—Two or more runways at the same airport whose centerlines are parallel. In addition to runway number, parallel runways are designated as L (left) and R (right) or, if three parallel runways exist, L (left), C (center), and R (right).

Runway, Rotary-wing— A runway for rolling landings and take-off of rotary-wing aircraft. The rotary-wing runway allows for a helicopter to quickly land and roll to a stop compared to the hovering stop used during a vertical helipad approach.

Runway Threshold—A line perpendicular to the runway centerline designating the beginning of that portion of a runway usable for landing.

Runway Visual Range—The maximum distance in the direction of take-off or landing from which the runway, or the specified lights or markers delineating it, can be seen from a position above a specified point on its centerline at a height corresponding to the average eye-level of pilots at touchdown.

Service Point—A receptacle, embedded in certain airfield pavements, containing outlets for utilities required to service aircraft.

Shoulder—A prepared (paved or unpaved) area adjacent to the edge of an operational pavement.

Slide Area, Helicopter—A specially prepared but usually unpaved area used for practicing helicopter landings under simulated engine failure or certain other emergency conditions. VFR Helicopter runway criteria apply to these type facilities. (Also known as a Skid Pad.)

Slope Ratio—A slope expressed in meters [feet] as a ratio of the horizontal to the vertical distance. For example, 50:1 means 50 meters horizontal to 1 meter vertical [50 feet horizontal to 1 foot vertical].

Standard VFR Helipad—A helipad designed to Visual Flight Rules (VFR). VFR design standards are used when no requirement exists or will exist in the future for an IFR helipad.

Standby Parking Pad—At individual helipad sites where it is necessary to have one or more helicopters on standby, an area adjacent to the helipad, but clear of the landing approach and transitional surfaces.

Suppressed Power Check Pad—A suppressed power check pad is an enclosed power check pad, referred to as a "hush house," where full power checks of jet engines are performed.

Takeoff and Landing Area—A specially prepared or selected surface of land, water, or deck designated or used for takeoff and landing of aircraft.

Takeoff Safety Zone—A clear graded area within the approach-departure zone of all VFR rotary-wing facilities. The land use of this area is comparable to the clear zone area applied to fixed-wing facilities.

Taxilane—A designated path marked through parking, maintenance or hangar aprons, or on the perimeter of such aprons to permit the safe ground movement of aircraft operating under their own power.

Taxilane, Interior—A taxilane which provides a secondary taxi route to individual parking positions or a hangar and is not intended or used as a primary taxi route for through traffic.

Taxilane, Peripheral—A taxilane located along the periphery of an apron and intended as a primary taxi route.

Taxilane, Through—A taxilane providing a route through or across an apron which is intended as a primary taxi route for access to other taxilanes, aprons, taxiways or the runway.

Taxiway—A specially prepared or designated path, on an airfield or heliport other than apron areas, on which aircraft move under their own power to and from landing, service and parking areas.

Taxiway, Apron Entrance—A taxiway which connects a parallel taxiway and an apron.

Taxiway, End Turnoff (Entrance Taxiway) (Connecting Taxiway) (Crossover Taxiway)—A taxiway located at the end of the runway that serves as both an access and departure location for aircraft at the runway thresholds.

Taxiway, High-Speed Turnoff (High-Speed Exit) (Acute-angled Exit Taxiway)—A taxiway located intermediate of the ends of the runway and "acute" to the runway centerline to enhance airport capacity by allowing aircraft to exit the runways at a faster speed than normal turnoff taxiways allow. Aircraft turning off runways at high speeds (maximum 100 kmph [55 knots]) require sufficient length for a high-speed turnoff taxiway to decelerate to a full stop before reaching the parallel taxiway.

Taxiway, Normal Turnoff (Ladder Taxiway) (Intermediate Taxiway) (Exit Taxiway)—A taxiway located intermediate of the end of the runway, typically perpendicular to the runway centerline that allows landing aircraft to exit and clear runways as soon as possible.

Taxiway, Parallel—A taxiway which parallels the runway. The curved connections to the end of the runway permit aircraft ground movement to and from the runway and are considered part of the parallel taxiway when there are no other taxiway exits on the runway.

Taxiway Turnoff—A taxiway leading from a runway to allow landing aircraft to exit and clear the runway after completing their initial landing roll.

Threshold Crossing Height—The height of the straight line extension of the guide slope above the runway at the threshold.

Tiedown Anchor—A device, installed in certain airfield pavements, to which lines tying down an aircraft are secured. Grounding may be provided.

Touchdown Point—A designated location on a landing lane, taxiway, or runway for permitting more rapid launch or recovery of helicopters in a high density area.

Towway—A paved surface over which an aircraft is towed.

Transitional Surface— An imaginary surface that extends outward and upward at right angles to the runway centerline and the runway centerline extended at a slope ratio of 7H:1V. The transitional surface connects the primary and the approach departure clearance surfaces to the inner horizontal, the conical, and the outer horizontal surfaces.

Transitional Surfaces (Rotary-Wing)—The imaginary plane which connect the primary surface and the approach-departure clearance surface to the horizontal surface, or extends to a prescribed horizontal distance beyond the limits of the horizontal surface. Each surface extends outward and upward at a specified slope measured perpendicular to the runway centerline or helipad longitudinal centerline (or centerlines) extended.

True North—The direction from an observer's position to the geographic North Pole. The north direction of any geographic meridian.

Unsuppressed Power Check Pad—A power check pad without an enclosure or other type of noise suppressor. It is generally used as a back up or interim facility to a suppressed power check pad. The unsuppressed power check pad, in its simplest form, is a paved area on which full power engine diagnostic testing can be performed without noise or jet blast limitations.

Visual Flight Rules (VFR)—Rules that govern the procedures for conducting flight under visual conditions. Also see Visual Meteorological Conditions.

Visual Meteorological Conditions (VMC)—Weather conditions in which visual flight rules apply; expressed in terms of visibility, ceiling height, and aircraft clearance from clouds along the path of flight. When these criteria do not exist, instrument meteorological conditions prevail and instrument flight rules must be complied with. Also see Visual Flight Rules.

Vertical Sight Distance—The longitudinal distance visible from one location to another. Usually, a height above the pavement surface is also defined.

V-STOL—A tilt-rotor Vertical Take-Off and Landing Aircraft, that has the ability to operate as either a fixed- or rotary-wing aircraft.

Wind Rose—A diagram showing the relative frequency and strength of the wind in correlation with a runway configuration and in reference to true north. It provides a graphic analysis to obtain the total wind coverage for any runway direction.

Wind Direction—The direction from which the wind is blowing in reference to true north.

Attachment 2

WAIVER PROCESSING PROCEDURES

A2.1. Army:

A2.1.1. Waiver Procedures:

A2.1.1.1. Installation. The installation's design agent, aviation representative (Safety Officer, Operations Officer, and/or Air Traffic and Airspace AT&A Officer) and DEH Master Planner will:

A2.1.1.1.1. Jointly prepare/initiate waiver requests.

A2.1.1.1.2. Submit requests through the installation to the Major Command (MACOM).

A2.1.1.1.3. Maintain a complete record of all waivers requested and their disposition (approved or disapproved). A list of waivers to be requested and those approved for a project should also be included in the project design analysis prepared by the design agent, aviation representative, or DEH Master Planner.

A2.1.1.2. The MACOM will:

A2.1.1.2.1. Ensure that all required coordination has been accomplished.

A2.1.1.2.2. Ensure that the type of waiver requested is clearly identified as either "Temporary" or "Permanent." "Permanent Waivers" are required where no further mitigative actions are intended or necessary.

A2.1.1.2.2.1. "Temporary Waivers" are for a specified period during which additional actions to mitigate the situation must be initiated to fully comply with criteria or to obtain a permanent waiver. Followup inspections will be necessary to ensure that mitigative actions proposed for each Temporary Waiver granted have been accomplished.

A2.1.1.2.3. Review waiver requests and forward all viable requests to U. S. Army Aeronautical Service Agency (USAASA) for action. To expedite the waiver process, MACOMs are urged to simultaneously forward copies of the request to:

A2.1.1.2.3.1. Director, U. S. Army Aeronautical Services Agency (USAASA), ATTN: MOAS-AI, 9325 Gunston Road, Suite N319, Fort Belvior, VA 22060-5582.

A2.1.1.2.3.2. Commander, U.S. Army Safety Center (USASC), ATTN: CSSC-SPC, Bldg. 4905, 5th Ave., Fort Rucker, AL 36362-5363.

A2.1.1.2.3.3. Director, U. S. Army Aviation Center (USAAVNC), ATTN: ATZQ-ATC-AT, Fort Rucker, AL 36362-5265.

A2.1.1.2.3.4. Director, USACE Transportation Systems Center (TSMCX), ATTN: CEMRO-ED-TX, 215 N 17th St., Omaha, NE 68102.

A2.1.1.3. USAASA. USAASA is responsible for coordinating the following reviews for the waiver request:

A2.1.1.3.1. Air traffic control assessment by USAAC.

A2.1.1.3.2. Safety and risk assessment by USASC.

A2.1.1.3.3. Technical engineering review by TSMCX.

A2.1.1.3.4. From these reviews, USAASA formulates a consolidated position and makes the final determination on all waiver requests and is responsible for all waiver actions for Army operational airfield/airspace criteria.

A2.1.2. Contents of Waiver Requests. Each request must contain the following information:

A2.1.2.1. Reference to the specific standard and/or criterion to be waived by publication, paragraph, and page.

A2.1.2.2. Complete justification for noncompliance with the airfield/airspace criteria and/or design standards. Demonstrate that noncompliance will provide an acceptable level of safety, economics, durability and quality for meeting the Army mission. This would include reference to special studies made to support the decision. Specific justification for waivers to criteria and allowances must be included as follows:

A2.1.2.2.1. When specific site conditions (physical and functional constraints) make compliance with existing criteria impractical and/or unsafe; for example: the need to provide hangar space for all aircraft because of recurring adverse weather conditions; the need to expand hangar space closer to and within the runway clearances due to lack of land; maintaining fixed-wing Class A clearances when support of Class B fixed-wing aircraft operations are over 10% of the airfield operations.

A2.1.2.2.2. When deviation(s) from criteria fall within a reasonable margin of safety and do not impair construction of long range facility requirements; for example, locating security fencing around and within established clearance areas.

A2.1.2.2.3. When construction that does not conform to criteria is the only alternative to meet mission requirements. Evidence of analysis and efforts taken to follow criteria and standards must be documented and referenced.

A2.1.2.3. The rationale for the waiver request, including specific impacts upon assigned mission, safety, and/or environment.

A2.1.3. Additional Requirements:

A2.1.3.1. Operational Factors. Include information on the following existing and/or proposed operational factors used in the assessment:

A2.1.3.1.1. Mission urgency.

A2.1.3.1.2. All aircraft by type and operational characteristics.

A2.1.3.1.3. Density of aircraft operations at each air operational facility.

A2.1.3.1.4. Facility capability (VFR or IFR).

A2.1.3.1.5. Use of self-powered parking versus manual parking.

A2.1.3.1.6. Safety of operations (risk management).

A2.1.3.1.7. Existing NAVAIDS.

A2.1.3.2. Documentation. Record all alternatives considered, their consequences, necessary mitigative efforts, and evidence of coordination.

A2.2. Air Force:

A2.2.1. Waivers to Criteria and Standards. When obstructions violate airfield imaginary surfaces or safe clearance criteria established in this manual, they must be analyzed to determine impact to aircraft operations. Facilities listed as permissible deviations (see attachment 14) do not require waiver if sited properly. Facilities constructed under previous standards should be documented as exemptions and programmed for replacement away from the airfield environment at the end of their normal life cycle, or when mission needs dictate earlier replacement. When documenting waiverable items, consider grouping adjacent supporting items with a controlling obstruction, or grouping related items such as a series of drainage structures, as one waiver. ***Example:*** The base operations building violates the 7H:1V Transitional Surface and apron clearance criteria. There are also four utility poles, a 36-inch tall fire hydrant, and numerous trees and shrubs located on the side of the building that is farthest away from the apron. These items are essential to provide architectural enhancement and utilities for this structure, but they also violate apron clearance criteria. Because these items are isolated from aircraft operations by the base operations building, they would not become a hazard to aircraft operations until the base operations building is relocated. Therefore, the base operations building is the controlling obstruction. Document the base operations building as an exemption (constructed under previous standards) and develop one waiver request for all supporting structures to analyze impact to aircraft operations.

A2.2.1.1. Temporary Waivers (One Year or Less). Establish temporary waivers for obstructions caused by construction activities by documenting the deviations and establishing a plan (including the issuance of NOTAMs or airfield advisories) that will allow safe operations during the temporary period. Coordinate the plan with airfield management, flying safety, and flight operations before asking the Wing Commander for approval.

A2.2.1.2. Permanent Waivers. Use a permanent waiver when:

A2.2.1.2.1. Natural geographical features violate criteria, and it is not economical or practical to remove them.

A2.2.1.2.2. Existing facilities deviate from criteria but removal is not feasible.

A2.2.1.2.3. Installation, construction, or erection of a required facility or equipment item according to criteria in this manual is not practical.

A2.2.1.2.4. Removal of the cause of the violation of criteria is not economical or practical.

A2.2.2. Waiver Authority. Major Commands (MAJCOM) may waive deviation from airfield and airspace criteria in this manual. The responsible MAJCOM Civil Engineer approves the waiver after coordination with all appropriate staff offices and concurrence by the MAJCOM Directors of Operations and Safety. The appropriate staff office for the Air National Guard (ANG) is ANGRC/CEPD. This authority is not delegated below MAJCOM level unless published as a MAJCOM policy. The following are exceptions:

A2.2.2.1. Permissible deviations to airfield and airspace criteria, which do not require waivers, are listed in Attachment 14 to this manual.

A2.2.2.2. Permanent waivers may require approval or coordination from various field operating agencies when AFI 32-1042, *Standards for Marking Airfields* or AFI 32-1076, *Visual Air Navigation Facilities*, standards apply.

A2.2.2.3. Waiver approval is required according to AFMAN 11-230, *Instrument Procedures*, when deviations from criteria in AFMAN 32-1076 would constitute deviations from the instrument procedure criteria or obstructions to air navigational criteria in AFMAN 11-230 or AFJMAN 11-226, *United States Standard for Terminal Instrument Procedures (TERPS)*.

A2.2.2.4. Authority is delegated to the Wing Commander when temporary waivers for construction activities are involved.

A2.2.3. Deviations From Criteria for Land Not Under Air Force Jurisdiction. Refer waivers to airfield and airspace criteria on land not under Air Force jurisdiction to the next level of command for ultimate resolution.

A2.2.4. Effective Length of Waiver. Waivers will be reviewed annually.

A2.2.5. Responsibilities:

A2.2.5.1. HQ AFCESA/CESC:

A2.2.5.1.1. Recommends policy on waivers and provides technical assistance on the waiver program.

A2.2.5.2. HQ AFFSA/XA:

A2.2.5.2.1. Reviews all requests for waivers (operational requirements) to siting criteria and airspace requirements.

A2.2.5.2.2. Approves all requests for waivers to instrument procedure criteria in AFMAN 11-230 or AFJMAN 11-226.

A2.2.5.2.3. Processes requests for waivers according to AFMAN 11-230.

A2.2.5.3. MAJCOM/CE:

A2.2.5.3.1. Coordinates with flight operations and flight safety offices to grant waivers.

A2.2.5.3.2. Sets and enforces reasonable safety precautions.

A2.2.5.3.3. Monitors actions to correct temporarily waived items within specified periods.

A2.2.5.3.4. Establishes procedures to ensure an annual review of all waived items.

A2.2.5.3.5. Establishes the administrative procedures for processing waivers.

A2.2.5.3.6. Maintains (for record) one copy of all pertinent documents relative to each waiver, including a record of staff coordination on actions at base and command levels.

A2.2.5.4. Base Civil Engineer:

A2.2.5.4.1. Coordinates with base flight safety, airfield management, and flight operations offices to request waivers.

A2.2.5.4.2. Following Airfield Management, Flight Safety, and Civil Engineer analysis and recommendation about a waiverable condition, annotates proposed waiver location on appropriate E series map for MAJCOM evaluation.

A2.2.5.4.3. Establishes maps of approved waivered items in accordance with AFI 32-7062, Base Comprehensive Planning, and maintains this information on the appropriate E-series map (see AFI 32-7062, Attachment 7). Also see AFJMAN 11-226 US Standard for Terminal Instrument Procedures (TERPS), and AFMAN 11-230, Instrument Procedures.

A2.2.5.4.4. Develops a Military Construction Program or other project to systematically correct non-permanent waivers.

A2.2.5.4.5. Presents a summary of waived items to the Facility Board each year for information and action.

A2.2.5.4.6. Establishes a procedure for recording, reviewing, and acting on waivers. Maintains records similar to those required at the MAJCOM.

A2.2.5.4.7. Requests a temporary waiver from the facility commander for any construction projects which violate any airfield clearance criteria during or after the completion of the construction project. The base must request a temporary waiver at least 45 days before the scheduled construction start date, or an emergency temporary waiver when 45 days are not possible. **NOTE:** Quick reaction or emergency maintenance and repair requirements are exempt from this requirement; however, the Base Civil Engineer will coordinate with base flight safety and flight operations offices to ensure implementation of safety measures.

A2.2.5.4.8. Advises the MAJCOM of any canceled waivers.

A2.2.5.5. ANGRC/CEP (for ANG facilities):

A2.2.5.5.1. Develops policy on waivers and manages the ANG waiver program.

A2.2.5.5.2. Processes and coordinates inquiries and actions for deviations to criteria and standards.

A2.3. Navy and Marine Corps:

A2.3.1. Applicability:

A2.3.1.1. Use of Criteria. The criteria in this manual apply to Navy and Marine Corps aviation facilities located in the United States, its territories, trusts, and possessions. Where a Navy or Marine Corps aviation facility is a tenant on a civil airport, use these criteria to the extent practicable; otherwise, FAA criteria apply. Where a Navy or Marine Corps aviation facility is host to a civilian airport, these criteria will apply. Apply these standards to the extent practical at overseas locations where the Navy and Marine Corps have vested base rights. While the criteria in this manual are not intended for use in a theater-of-operations situation, they may be used as a guideline where prolonged use is anticipated and no other standard has been designated.

A2.3.1.2. Criteria at Existing Facilities. The criteria will be used for planning new aviation facilities and new airfield pavements at existing aviation facilities (exception: primary surface width for Class B runway). Existing aviation facilities have been developed using previous standards which may not conform to the criteria herein. Safety clearances at existing aviation facilities need not be upgraded solely for the purpose of conforming to this criteria. However, at existing aviation facilities where few structures have been constructed in accordance with previous safety clearances, it may be feasible to apply the revised standards herein.

A2.3.2. Approval. Approval from Headquarters NAVFACENGCOM must be obtained prior to revising safety clearances at existing airfield pavements to conform with new standards herein. NAVFACENGCOM will coordinate the approval with the Naval Air Systems Command and CNO/CMC as required.

A2.3.3. Obtaining Waiver. Once safety clearances have been established for an aviation facility, there may be occasions where it is not feasible to meet the designated standards. In these cases a waiver must be obtained from the Naval Air Systems Command. The waiver and its relation to the site approval process is defined in NAVFACINST 11010.44, *Shore Facilities Planning Manual*.

A2.3.4. Exemptions From Waiver. Certain navigational and operational aids normally are sited in violation of airspace safety clearances in order to operate effectively. The following aids are within this group and require no waiver from NAVAIR, provided they are sited in accordance with NAVFAC Definitive Designs (P-272) and/or the NAVFAC Design Manuals (DM Series):

A2.3.4.1. Approach lighting systems.

A2.3.4.2. Visual Approach Slope Indicator (VASI) systems and Precision Approach Path Indicator (PAPI).

A2.3.4.3. Permanent Optical Lighting System (OLS), portable OLS and Fresnel lens equipment.

A2.3.4.4. Runway distance markers.

A2.3.4.5. Arresting Gear systems including signs.

A2.3.4.6. Taxiway guidance, holding, and orientation signs.

A2.3.4.7. All beacons and obstruction lights.

A2.3.4.8. Arming and de-arming pad.

Attachment 3

ARMY LAND USE AND FACILITY SPACE -- ALLOWANCES

A3.1. Applicability:

A3.1.1. This Attachment does not apply to the Air Force. For Air Force Facility Space Allowances, see AFI 32-1024, *Standard Facility Requirements,* and AFH 32-1084, *Facility Requirements Handbook.*

A3.1.2. This Attachment does not apply to the Navy and Marine Corps. For Navy and Marine Corps Facility Space Allowances, see NAVFAC P-80, *Facility Planning Factor Criteria for Navy and Marine Corps Shore Installations*.

NOTE: Metric units apply to new airfield construction, and where practical, modifications to existing airfields and heliports, as discussed in paragraph 1.4.4.

Table A3.1. Facility Class 1: Operational and Training Facilities, Category Group 11: Airfields Pavement, General

Category Code		Item and Allowance
110		**AIRFIELD PAVEMENTS**
111		**Airfield Pavements - Runways** Pavements that are designed and constructed for the safe takeoff and landing operations of rotary- and fixed-wing aircraft.
	11110	**Fixed-Wing Runway, Surfaced** A flexible or rigid paved airfield surface used for normal takeoffs and landings of fixed-wing aircraft. It can also accommodate rotary-wing aircraft. From an operational point of view, the runway includes the prepared landing surface, shoulders, overruns, plus various cleared areas and airspace. For inventory purposes, only the prepared runway surface is included. One Fixed-wing runway is allowed at an aviation facility. For Class A, basic dimensions are 30 m [100 ft] wide, and length as shown in Table 3.3. For Class B, width and length requirements are shown in Table 3.2.
	11111	**Fixed-Wing Runway, Unsurfaced** An unpaved, prepared surface for training, emergency, and other special takeoff and landing operations of fixed-wing aircraft. It can also accommodate rotary-wing aircraft. From an operational point of view, the runway includes the landing surface, shoulders, overruns, plus various cleared areas and airspace. For inventory purposes, only the prepared runway surface is included.

	11120	**Rotary-Wing Runway, Surfaced** A paved airfield or heliport surface provided for the exclusive use of rotary-wing takeoffs and landings. Marked surfaces used as reference or control points for arriving and departing aircraft (hoverpoints) are part of the runway. From an operational point of view, the runway includes the prepared landing surface, shoulders, overruns plus various cleared areas and airspace. For inventory purposes, only the prepared runway surface is included. Basic dimensions are 23 m [75 ft] wide, 490 m [1,600 ft] long. A runway may be provided when helicopter companies are authorized at heliports at Army airfields when air traffic density or other operational problems prohibit mixing of medium rotary- and fixed-wing aircraft.
	11121	**Rotary-Wing Runway, Unsurfaced** An unpaved, prepared surface used exclusively for training, emergency, and other special takeoff and landing operations of rotary-wing aircraft. From an operational point of view, the runway includes the prepared landing surface, shoulders, overruns, plus various cleared areas and airspace. For inventory purposes, only the prepared runway surface is included.
	11130	**Rotary-Wing Landing Pads, Surfaced** A paved surface for takeoffs and landings of rotary-wing aircraft. It is physically smaller than a rotary-wing runway and is normally located at a site that is remote from an airfield or heliport. From and operational point of view, the helipad includes the prepared landing surface and shoulders, plus various cleared areas and airspace. For inventory purposes, only the prepared surface is included. Helipads designed and constructed for vertical takeoff and landing of helicopters will be authorized for isolated sites, for support of infrequent operation requirements, for sites which cannot physically support limitations of land and/or airspace or economically justify airfield/heliport development, or at airfield/heliports with high air traffic density which require one or more helipads for establishment of safe aircraft traffic control patterns. Where several helipads are required to serve adjacent high density parking areas, they may be connected by airfield pavement for more rapid landing and takeoff operations. Helipads so connected may be referred to as "helicopter landing strips", or "lanes", not to be confused with helicopter runways. Helipad criteria is applicable to these type facilities. One helipad is allowed at Hospitals. Basic dimensions are 30 m by 30 m [100 ft by 100 ft]. Stabilized shoulders will be provided around helipads and along any connecting pavements.

	11131	**Rotary-Wing Landing Pads, Unsurfaced** An unpaved prepared surface which is, centered within a clear area, and used exclusively for training, emergency, and other special landing and takeoff operations of rotary-wing aircraft. From an operational point of view, the helipad includes the prepared landing surface and shoulders, plus various cleared areas and airspace. For inventory purposes, only the prepared surface is included.
	11140	**Hoverpoint** One or more lighted hoverpoints may be authorized at an airfield or heliport where air traffic density requires the constant separation of fixed-wing and rotary-wing traffic or the establishment of separate helicopter traffic patterns or when instrument approach procedures are not possible to a terminal (final) landing area. The hoverpoint is normally a nontraffic area used for air traffic control reference. It consists of a paved 9 m [30 ft] diameter identifier marker centered in a 45.72 m by 45.72 m [150 ft by 150 ft] clear area. Standard helipad approach-departure and transitional surfaces will be provided. The number and location of hoverpoints authorized are dependent upon the helicopter traffic pattern requirements at each particular facility.
112	**Airfield Pavements-Taxiways** An all weather surface designed and constructed for the safe and efficient powered ground movement of aircraft between runway systems and other paved aircraft operational, maintenance, and parking facilities.	
	11212	**Fixed-Wing Taxiways, Surfaced** Paved surfaces which serves as designated pathways on an airfield and are constructed for taxiing fixed-wing aircraft. From an operational point of view, a taxiway includes the prepared surface, markings, stabilized shoulders, lighting and lateral clearance zones. For inventory purposes, only the prepared surface is included. For Class A runways, paved surfaces are 15 m [50 ft] and for Class B runways, paved surfaces are 23 m [75 ft] wide. At Short Field and Training Assault Landing Zones 15 m [50 ft] is the standard width. Lengths and locations will be as shown on the Department of the Army approved Master Plan of the airfield/heliport.
	11213	**Fixed-Wing Taxiway, Unsurfaced** Unpaved prepared surfaces which serve as designated pathways on an airfield and are constructed for taxiing fixed-wing aircraft. From an operational point of view, a taxiway includes the prepared surface, stabilized shoulders and lateral clearance zones. For inventory purposes, only the prepared surface is included.
	11221	**Fixed-Wing Taxiway, Surfaced** Paved surfaces which serve as designated pathways on an airfield or heliport and are constructed for taxiing rotary-wing aircraft. From an operational point of view, a taxiway includes the prepared surface, markings, stabilized shoulders, lighting and lateral clearance zones. For inventory purposes, only the prepared surface is included At helicopter only facilities, a basic width of 15 m [50 ft] is authorized. When dual-use taxiways support Fixed-Wing operations, use appropriate Fixed-Wing taxiway criteria.

	11222	**Rotary-Wing Taxiway, Unsurfaced** Unpaved prepared surfaces which serve as designated pathways on an airfield or heliport and are constructed for taxiing rotary-wing aircraft. From an operational point of view, a taxiway includes the prepared surface, stabilized shoulders, and lateral clearance zones. For inventory purposes, only the prepared surface is included.

113 Airfield Pavements - Aprons

Prepared surfaces, other than runways and taxiways, where aircraft are parked or moved about the airfield area. They are designed to support specific types of aircraft and to meet operational requirements such as maintenance and loading/unloading activities.

The permanent peace time operation and maintenance of Army aircraft requires construction of apron areas to assure safe, efficient and economical accomplishment of the mission.

For Fixed-Wing; rigid pavement areas with standard aircraft tiedowns spaced 6 m [20 ft] on centers throughout the usable parking apron area are authorized for parking, maintenance, and hangar access apron areas. Parking aprons should be designed to permit 85% of the authorized aircraft to park under their own power [75% operational parking and 10% maintenance operational checks (MOC)). The remaining 15% are parked in maintenance facility buildings. When an area is inadequate to permit this capability, operational parking capacity may be reduced to not less than 50% of the 85% with the balance of the 85% being provided surfaced manual parking area. Standard aircraft tiedowns conforming to criteria in Appendix K of this Manual should be used. These tiedowns also serve as the static grounding points.

For Rotary-Wing; see Chapter 6 for additional information. The number of Army rotary-wing aircraft used to estimate apron area is 85% of the authorized aircraft. This assumes that 75% of the aircraft will be operational and 10% will be parked for MOC's. The remaining 15% of the authorized aircraft can be assumed to be in maintenance facilities. Any substantial difference to exceed this allowance should be authenticated and submitted as a request to the MACOM to exceed this allowance.

	11310	**Fixed-Wing Parking Apron, Surfaced** A paved airfield surface used for fixed-wing aircraft parking. The area includes parking lanes, taxilanes, exits, and entrances. Aircraft move under their own power to the parking spaces, where they may be parked and secured with tiedowns. Parking designed to distribute aircraft, for the purpose of increased survivability (dispersed hardstands), is included in this category code. From an operational point of view, an apron includes the prepared surface, tiedowns, markings, stabilized shoulders, lighting, and lateral clearance zones. For inventory purposes, only the prepared surface is included. Parking aprons for Army fixed-wing aircraft will normally be based on the C-12 A-C (Huron) with a wingspan of 17 m [55 ft] and length of 18.25 m [60 ft]. However, mission requirements may require different aircraft dimensions. The width of the parking lane should be equal to the aircraft length. The length of a row will be equal to the number of aircraft times the aircraft wingspan plus the distance between parked aircraft wingtips, as shown in Table 6.1 of this Manual. The taxilane clear-width for Interior, through and peripheral taxilanes is shown in Table 6.1 of this Manual. Paved shoulders will be provided. When a taxilane is to be jointly used by Army fixed-wing and other types of aircraft, such as helicopters or Air Force aircraft, then this common taxilane width will be increased an appropriate amount to accommodate the critical use aircraft. At facilities such as flight training centers, where one type of aircraft predominates, the dimensions of the specific type will be used in lieu of the C-12.

	11311	**Fixed-Wing Parking Apron, Unsurfaced** An unpaved, prepared airfield surface used for fixed-wing aircraft parking. The area includes parking lanes, taxilanes, exits, and entrances. Aircraft move under their own power to the parking spaces, where they may be parked and secured with tiedowns. Parking designed to distribute aircraft, for the purpose of increased survivability (dispersed hardstands), is included in this category code. From an operational point of view, an apron includes the prepared surface, tiedowns, stabilized shoulders, and lateral clearance zones. For inventory purposes, only the prepared surface is included.
	11320	**Rotary-Wing Parking Apron, Surfaced** A paved airfield surface used for rotary-wing aircraft parking. The area includes parking lanes, taxilanes, exits, and entrances. Aircraft move under their own power to the parking spaces where they may be parked and secured with tiedowns. Parking designed to distribute aircraft for the purpose of increased survivability (dispersed hardstands) is included in this category code. From an operational point of view, an apron includes the prepared surface, tiedowns, markings, stabilized shoulders, lighting, and lateral clearance zones. For inventory purposes, only the prepared surface is included. Parking aprons for Army rotary-wing aircraft will be based on the type of rotary-wing aircraft and parking arrangement, as discussed in Chapter 6 of this Manual. Rotary-wing taxilane widths will be as shown in Table 6.2 of this Manual. Paved shoulders will be provided.
	11321	**Rotary-Wing Parking Apron, Unsurfaced** An unpaved, prepared airfield surface used for rotary-wing aircraft parking. The area includes parking lanes, taxilanes, exits, and entrances. Aircraft move under their own power to the parking spaces, where they may be parked and secured with tiedowns. Parking designed to distribute aircraft, for the purpose of increased survivability (dispersed hardstands) is included in this category code. From an operational point of view, an apron includes the prepared surface, tiedowns, stabilized shoulders, and lateral clearance zones. For inventory purposes, only the prepared surface is included.
	11330	**Aircraft Maintenance Parking Apron, Surfaced** A paved apron for parking fixed- or rotary-wing aircraft awaiting maintenance. Mass aircraft parking aprons are authorized for Aviation Intermediate Maintenance (AVIM) maintenance shop units which have a responsibility for maintenance of aircraft from other facilities or aviation units. For planning purposes, an apron area of up to 11,700 m^2 [14,000 yd^2] is normally sufficient to meet this requirement. Aircraft will be manually parked on this apron. Separate maintenance parking aprons are not authorized for aviation units which have their own AVIM maintenance capability.
	11331	**Aircraft Maintenance Parking Apron, Unsurfaced** An unpaved, prepared apron for parking fixed- or rotary-wing aircraft awaiting maintenance.

	11340	**Hangar Access Apron, Surfaced** A paved surface that connects an aircraft parking apron with a hangar. It is generally equipped with tiedowns and grounding devices. From an operational point of view, an apron includes the prepared surface, tiedowns, grounding devices, stabilized shoulders, lighting from the hangar, and lateral clearance zones. For inventory purposes, only the prepared surface is included. Hangar access aprons will be provided as a supporting item for each authorized hangar and will be sized for the type of hangar and aircraft to be accommodated and to meet the requirements of site development as shown on a Department of the Army approved general site plan. The access apron will be designed as rigid pavement. Access aprons should be as wide as the hangar doors. Hangar access aprons are further discussed in Chapter 6 of this Manual.
	11341	**Hangar Access Apron, Unsurfaced** An unpaved, prepared surface that connects an aircraft parking apron with a hangar. It is generally equipped with tiedowns and grounding devices. From an operational point of view, an apron includes the prepared surface, tiedowns, grounding devices, stabilized shoulders, lighting from the hangar, and lateral clearance zones. For inventory purposes, only the prepared surface is included.
	11350	**Aircraft Runway Holding Apron, Surfaced** A paved surface which provides an aircraft holding area that is accessible from a taxiway. It is located near the intersection of taxiways and at the ends of runways. It is provided for pre-takeoff engine and instrument checks. From an operational point of view, an apron includes the prepared surface, stabilized shoulders, lighting, and lateral clearance zones. For inventory purposes, only the prepared surface is included. Aircraft (engine run up) holding aprons are authorized for each runway. The area for the holding apron will be sized to accommodate those assigned and transient aircraft which normally use the runway and should not exceed 3135 m^2 [3,750 yd^2] each, without submitting special justification. Holding aprons are usually programmed with, and as a part of, the parallel taxiway system.
	11351	**Aircraft Runway Holding Apron, Unsurfaced** An unpaved, prepared surface which provides an aircraft holding area that is accessible from a taxiway. It is located near the intersection of taxiways and at the ends of runways. It is provided for pre-takeoff engine and instrument checks. From an operational point of view, an apron includes the prepared surface, stabilized shoulders, and lateral clearance zones. For inventory purposes, only the prepared surface is included.

	11370	**Aircraft Washing Apron, Surfaced** A rigid pavement area for washing and cleaning aircraft. It normally includes electrical and water service, drainage, and waste water collection equipment. From an operational point of view, an apron includes the prepared surface, stabilized shoulders, lighting and lateral clearance zones. For inventory purposes, only the prepared surface is included. A washing apron is authorized for each aircraft maintenance hangar. Washing aprons will be sized and dimensioned according to the number and type of aircraft to be washed, local environmental conditions (i.e., soil and climate), and scheduling. See paragraph 6.14.2. The wash apron will be provided with 110 volt electrical service, 25 mm [1 in] water service and compressed air. The wash apron will be provided with drainage facilities to include a facility for wash-waste treatment, including at least a 11,400 L [3,000 gal] capacity holding tank. The tank should be sized to the extent required for effluent to be suitable for discharge into a sanitary system. A collection area for P.O.L. waste and spillage should be provided, when required, in conjunction with the wash apron.
	11371	**Aircraft Washing Apron, Unsurfaced** An unpaved, prepared surface for washing and cleaning aircraft. It normally includes electrical and water service, drainage, and waste water collection equipment. From an operational point of view, an apron includes the prepared surface, stabilized shoulders, lighting and lateral clearance zones. For inventory purposes, only the prepared surface is included.
	11380	**Aircraft Loading Apron, Surfaced** A paved surface for loading cargo aircraft; loading personnel for medical evacuation, and transient aircraft operations; or providing an apron area for arming and disarming aircraft weapons, loading and unloading ammunition, special handling or decontamination of chemical, biological, radiological (CBR) warfare items, and for special security operations. An apron area in support of the airfield operations building, not to exceed 5,850 m^2 [7,000 yd^2,] may be authorized for purposes of handling special loading and unloading of personnel, for medical evacuation flights and for transient aircraft operations. (See Category 11382 for aprons requiring safety clearances and/or security facilities).
	11382	**Aircraft Special Purpose Apron** Special purpose aprons may be authorized for providing safe areas for arming and/or disarming aircraft weapons; loading and unloading ammunition; special handling and/or decontamination facilities for CBR warfare items; and for special security areas. Special-purpose aprons required to conduct defueling operations will be provided at Army aviation facilities. Design will be predicated on the largest aircraft and adequate space for fire support equipment and defueling vehicle and apparatus. Grounding points will be provided. The scope of the apron area and the type of supporting facilities for these special-purpose aprons will be individually justified on the basis of the mission requirements. Safety clearances, appropriate to the requirements of the apron, will be observed. Airfield maps and plans will identify the purpose of the apron

		and show the required safety clearance distances. Explosives clearances are discussed in Appendix I of this Manual.
	11383	**Aircraft Loading Aprons, Unsurfaced** An unpaved, prepared surface for loading cargo aircraft; loading personnel for medical evacuation and transient aircraft operations. An aircraft loading apron provides and area for arming and disarming aircraft weapons, loading and unloading ammunition, special handling or decontamination of chemical, biological radiological (CBR) warfare items, and for special security operations.
116	**Airfield Pavement, Miscellaneous**	
	11610	**Aircraft Compass Calibration Pads** A prepared surface for calibration of air navigation equipment. A rigid paved pad in a magnetically quiet zone of the airfield. The pad surface is painted with alignment markings which are used in the precise calibration of air navigation equipment. The facility may include a taxiway which connects the pad to the main taxiway or apron. One compass calibration pad may be provided at Army airfields or heliports where fifteen or more aircraft are permanently assigned, and at Army depots where aircraft maintenance missions are assigned (AR 750-1, *Army Material Maintenance Policies and Retail Maintenance Operations.* The compass calibration pad is a paved area which should be located in an electronically quiet zone of the airfield. Compass calibration pads are typically circular and are sized to accommodate one of the assigned or mission aircraft. Compass calibration pads are further discussed in Chapter 6 of this manual.

Table A3.2. Facility Class 1: Operational and Training Facilities, Category Group 12: Liquid Fueling and Dispensing Facilities

Category Code		Item and Allowance
120	**LIQUID FUELING AND DISPENSING FACILITIES**	
121	**Aircraft Dispensing** Facilities used to store and dispense liquid aviation fuels directly into aircraft or fueling trucks. These facilities consist of dispensing equipment, whose capacity is recorded in liter per minute (LM) [gallons per minute (GM)]. Control and fueling support buildings are operational facilities accounted for with category code 14165, Fueling/POL Support Building. The capacity of these facilities is based upon the flow rate of the pump facilities, (i.e., the number of liters per minute [gallons per minute]) which can be loaded into the aircraft and/or fuel truck.	
	12110	**Aircraft Direct Fueling Facility** A facility used for dispensing aircraft fuel under pressure from operational storage tanks directly into the fuel tanks of the aircraft.

	12120	**Aircraft Fuel Truck Loading Facility** A facility for transfer of aircraft fuels from storage tanks to refueling vehicles (tank, truck, fuel, and tank pump units).
	12410	**Aircraft Fuel Storage, AVGAS, Underground** Storage tanks used in support of direct fueling and/or fueling of aircraft that use aviation gasoline (AVGAS). See the 411 series for bulk fuel storage and 12412 for operational storage tanks above ground. Fuel storage should be installed underground. However, when the quantity of the product to be stored is of such magnitude as to create unreasonable demands in construction time or cost, aboveground storage should be considered. Aboveground considerations include available space, safety clearances, security requirements and underground construction conditions. Fuel storage allowances are for a 30-day supply and will be reduced to a 15-day supply where deliveries can be made within 7 days of placing an order. Where deliveries are to be made by tank car, the minimum fuel storage capacity for each type fuel will be 45,400 L [12,000 gal]. Fuel storage capacity of 18,900 L [5,000 gal] will be allowed for each kind of Army aircraft fuel, not provided for permanently assigned aircraft, to provide storage for fuel withdrawn from or required to refuel aircraft maintained but not assigned at the airfield. Requests for greater capacities or for fuel storage and dispensing facilities for types of aircraft fuel for other than Army aircraft at an Army airfield will be individually justified. Storage capacities will be calculated by the formula $a \times b \times c \div 12$ = 30-day requirement per aircraft and fuel type. a = the number of each type of Army aircraft assigned or planned to be assigned. b = the basic annual flying hour planning factor per type of aircraft, as listed in current FM 101-20, *US Army Aviation Planning Manual,* as a peacetime or noncombat environment. c = the fuel consumption rate per type of Army aircraft, as listed in FM 101-20. Use a factor of 0.78 kg per liter [6.5 lb per gallon]. Total storage capacities will be rounded to the nearest 18,900 L [5,000 gal] for quantities over 18,900 L [5,000 gal.] and to the nearest 3,780 L [1,000 gal.] for quantities under 18,900 L [5,000 gal.].
	12411	**Aircraft Fuel Storage, Jet, Underground** Storage tanks used in support of direct fueling and/or fueling of aircraft that use jet fuel (JP-4/5/8). See the 411 series for bulk fuel storage and 12413 for operational storage tanks above ground.
	12412	**Aircraft Fuel Storage, AVGAS, Aboveground** Storage tanks used in support of direct fueling and/or fueling of aircraft that use aviation gasoline (AVGAS). See the 411 series for bulk fuel storage and 12410 for operational storage tanks underground.

	12413	**Aircraft Fuel Storage, Jet, Aboveground** Storage tanks used in support of direct fueling and/or fueling of aircraft that use jet fuel (JP-4/5/8). See the 411 series for bulk fuel storage and 12411 for operational storage tanks underground.

Table A3.3. Facility Class 1: Operational and Training Facilities, Category Group 13: Air Navigation and Traffic Aids Building

Category Code		Item and Allowance
133		**Air Navigation and Traffic Aids Building** Facilities housing equipment and functions for air traffic control including flight control and navigational aids.
	13310	**Flight Control Tower** Terminal facilities which, by the use of communications systems, visual signaling, and other equipment, provide air traffic control service to aircraft at airfields or heliports. One control tower will be provided for each airfield or heliport in accordance with AR 95-2, *Air Traffic Control, Air Space, Airfield Flight Facilities and Navigational Aids.* Standards for control towers can be obtained from ATZQ-ATC-FG. The tower cab height will permit a clear view of the entire runway and taxiway system and may be combined with the airfield operations building and/or the fire and rescue station. The tower area will be approximately 260 gross m^2 [2,800 gross ft^2]. At facilities provided direct weather support by an Air Weather Service (AWS) detachment, a separate floor of the control tower may be modified or added to house a Representative Weather Observation Station (RWOS). The tower area for the RWOS will be 37 gross m^2 [400 gross ft^2]. An observation platform or catwalk may be provided around the exterior of the RWOS floor.
	13320	**Navigation Building, Air** A facility which houses designated types of equipment systems for the exchange of information between airfields and aircraft. Also included are air traffic control facilities which provide approach control services to aircraft arriving, departing, and transitioning the airspace controlled by the airfield or heliport. Unmanned structures containing regulators, relays. emergency generators, service feeder switches, and secondary control panels for lighting at airfields or heliports are also included. Type 0 (Equipment room only) 14.4 gross m^2 [156 gross ft^2] Type 1 (Equipment room plus one generator) 32.1 gross m^2 [344 gross ft^2] Type 2 (Equipment room plus two generators) 42.3 gross m^2 [452 gross ft^2] Type 3 (Equipment room plus three generators) 52.0 gross m^2 [560 gross ft^2] (Above types formerly contained in AFM 88-2.)

134	**Navigational and Traffic Aids, Other Than Buildings** Radar approach control, visual navigational aids, antenna systems, vaults, foundations, tower beacons, and other structures which support Army airfield or Army heliport operations.	
	13410	**Radio Beacon** Radio beacons are of three types: non-directional, air navigation marker, and terminal VHF omni-range (TVOR). The non-directional beacon (NDB) transmits a signal from which the pilot of a suitably equipped aircraft can determine the aircraft's bearing to or from the facility. The NDB operates in the frequency range of 200 to 535.5 kilohertz (kHz) with a variable radio frequency output power between 25 and 50 watts. An air navigation marker is part of an instrument landing system (ILS) and provides accurate radio fixes along the approach zone. Category II ILS require inner and outer markers. TVOR beacon transmits very high frequency (VHF) signals 360 degrees in azimuth, oriented from magnetic north. These signals provide aircraft with course and bearing information. The TVOR periodically identifies itself and may use voice recordings on an automatic terminal information service (ATIS) recorder. These facilities are normally small, unmanned structures. The facility excludes electronic equipment and antenna systems that form an integral, equipment-in-place (EIP) component of this navigational aid. As provided in the applicable TDA for each airfield/heliport in accordance with the provisions of AR 310-49, *The Army Authorization Documents Systems*.
	13430	**Ground Control Approach System** A radar approach system operated by air traffic control personnel in support of instrument flight rules (IFR) activities. The approach may be conducted with airport surveillance radar (ASR) only, or with both ASR and precision approach radar (PAR). The facility normally consists of small unmanned structures that house electronic equipment and other equipment installed in the control tower. The real property facility excludes electronic equipment and antenna systems that form an integral, equipment-in-place (EIP) component of this navigational aid. Instrument approach facilities normally authorized for precision-instrumented airfields will consist of a Ground Control Approach (GCA) System. (Requisitioning of equipment will be through the Army Communication Command (USACC) in accordance with AR 95-9, *Terminal Air Navigation and Air Traffic Control Facilities.*)
	13440	**Instrument Landing System** The Instrument Landing System (ILS) consists of three main elements: a directional localizer, a glide slope indicator, and radio marker beacons. These three precision electronic elements provide aircraft with course alignment, descent and range information, respectively, during instrument flight rules (IFR) approaches to the runway under adverse weather conditions or poor visibility. The ILS normally consists of small, unmanned facilities that house electronic equipment. The real

		property facility excludes electronic equipment and antenna systems that form an integral, equipment-in-place (EIP) component of this navigation aid. An Instrument Landing System (ILS) may be authorized at Army airfields where air navigational aids for use under Instrument Flight Rules (IFR) are required for operation or aircraft of other services, for commercial aircraft in support of Army missions or under air traffic conditions where a GCA facility, item 13430, would be inadequate. Special justification should be submitted to the Office of the Chief of Engineers for Department of the Army approval. Construction for foundations and equipment pads will be accomplished by the using service.
	13450	**Navigational Lighting** Navigational lighting consists of three types: rotating light beacon, flashing light beacon, and air navigation obstruction lighting. The rotating light beacon is the internationally recognized white and green flashing light signal that indicates an airfield. The facility normally consists of a high candlepower unmanned piece of equipment. Air navigation obstruction lighting is one or more electrically operated red, or high-intensity white lights that identify hazards to aircraft operation. Flashing and steady-burning red obstruction lights may be used during darkness or periods of reduced daytime visibility. Flashing high-intensity white lights may be used for both daytime and nighttime conditions. The facility normally consists of an unmanned piece of equipment.
	13470	**Wind Direction Indicator** A facility which provides a visual indication of surface wind direction at Army airfields, heliports and helipads. These facilities include wind socks, wind cones, and wind tees. Lights are used to illuminate the pointing device. The facility normally consists of an unmanned piece of equipment.
136	**Airfield and Heliport Pavement Lighting Systems** Lighting systems along both sides and the approaches of airport and heliport pavements. It excludes airfield perimeter lighting, security lighting, street lighting, and other general illumination (see the 812-series). Airfield and heliport lighting systems will include only the lighting facilities required for support of aircraft operational areas. Controls and equipment vault facilities will be included as necessary to provide a complete and usable system. Design and equipment will conform to criteria contained in TM 5-811-5, *Army Aviation Lighting*, AFMAN 32-1076, *Visual Air Navigation Facilities*, and NAVAIR 51-50-AAA-2, *General Requirements for Shore Based Airfield Marking and Lighting*. For programming purposes, runway, taxiway, hoverlane, and approach lighting requirements will be designated in linear meters [feet] (based on runway centerline length measurements). Helipad lighting will be designated in linear meters [feet] of a perimeter measurement.	
	13610	**Runway Lighting** Lighting consisting of two configurations of lights, one that defines the lateral (side) limits of the runway, and the other that defines the longitudinal threshold (end) limits of the runway. The lateral lights are called runway edge lighting and emit white light. The longitudinal lights are called inboard and winged-out threshold lighting. Each

		threshold fixture emits both red and green light. A medium-intensity system is approximately 45 watts, while a high-intensity system is approximately 200 watts. Floodlights to illuminate hoverpoints are included also. A runway lighting system consisting of runway edge lighting and threshold lighting will be authorized at airfields and/or heliports with surfaced runways. a. Medium intensity lighting with brightness control will be provided on noninstrument runways where justified for flight operations conducted under Visual Flight Rules (VFR). b. High intensity lighting with brightness control will be authorized on runways used for flight operations under Instrument Flight Rules (IFR).
	13612	**Approach Lighting System** A configuration of 7 to 15 light bars located along the extended centerline of the runway. These bars are typically elevated and have multiple fixtures that emit white light to assist aircraft in approaching the end of the runway. A Short Approach Lighting System (SALS) will normally be installed at the approach end of an instrument runway served by a Precision Approach Radar (PAR) or Instrument Landing System (ILS). A more extensive system may be approved based on ceiling and visibility minimums derived under TM 95-226, *United States Standard for Terminal Instrument Procedures (TERPS)*. for large transport aircraft where justification exists. A Medium Intensity Approach Lighting System (MALS) may be used where a precision approach is not available or justified.
	13613	**Precision Approach Path Indicator (PAPI)** A light system made up of red and white lights mounted on bars located near the landing end of the runway. The purpose of the PAPI is to visually assist pilots on their descent to the runway. A Precision Approach Path Indicator (PAPI) may be provided when justified by special requirements. The PAPI is designed to provide, by visual reference, the same information that the glide slope unit of an instrument landing system provides electronically. PAPIs provide a visual flight path within the approach zone, at a fixed plane inclined at 2.5 to 4 degrees from the horizontal, which an approaching fixed-wing aircraft pilot can visually utilize the PAPI for descent guidance during an approach to landing, under either daytime or nighttime conditions on instrument or visual runways.
	13615	**Rotary-Wing Parking Pad Lighting** A perimeter system of yellow lights around the edge of the rotary-wing landing/parking pad. It may also include other systems, such as a landing direction system which is a series of yellow lights placed along the extended landing pad centerline, and an approach system which is a series of white lights that extend out from the landing direction lights. Inset lights are a series of blue lights placed within the landing surface to aid depth perception. Landing pad flood lights are general illumination lights which are placed parallel to the normal approach. Lighting will be provided for helipads to be used at night and during periods of poor visibility.

	13620	**Taxiway Lighting** A configuration of lighting fixtures which defines the lateral limits of aircraft movement along a taxiway. The configuration normally consists of a line of blue lights paralleling each side of the taxiway, plus yellow entrance and exit lights. Taxiing routes between rotary-wing landing pads and apron areas (hoverlanes) have lights consisting of a single row of semi-flush blue lights illuminating the centerline. The ends of the centerlines may also be marked with red limit lights. Lighting is authorized for all taxiways and taxiways used as hoverlanes required to be used at night or during periods of poor visibility except access taxiways to compass calibration pads and weapon systems calibration pads. The exterior limits of all apron taxilanes will be lighted appropriately. The light intensity will be such as to provide adequate taxiing guidance for all meteorological conditions under which the system is to be used. Brightness control and entrance-exit signs may be provided when specifically authorized by Department of the Army.
	13621	**Holding Apron Lighting** A configuration of blue lights that illuminate the outer edges of a holding apron. Where programmed separately, the scope of holding apron lighting will be the actual length of the outer edges of each holding apron, including pavement fillets. See Item 13620 for taxiway lighting.
	13640	**Aircraft Lighting Equipment Vault** A single vault, not to exceed 44.5 gross m^2 [480 gross ft^2] will be provided for fixed-wing runway or separate heliport lighting equipment. A combination vault, not to exceed 70 gross m^2 [750 gross ft^2], will be provided where both fixed-wing runway and heliport lighting is provided. The area may be increased when a standby generator for the airfield lighting system is authorized.
	13670	**Parking Apron/Hardstand Lighting** Area or security lighting provided by permanently mounted floodlights, with power outlets. Normally the lights are located near the aircraft maintenance and parking areas adjacent to hangars, operations buildings, or other structures along the hangar line for the purpose of conducting maintenance, service, and loading/unloading operations. Aircraft maintenance and parking aprons adjacent to hangars, operations buildings, or other structures located along the hangar line may be floodlighted for purposes of conducting maintenance, service and loading and unloading operations. When these areas are lighted, the floodlight fixtures will be mounted on the structures and/or on poles. If floodlights are pole-mounted, the poles must be located outside of the apron clearance areas. Normally this lighting is programmed as a part of a hangar construction project included as a supporting item and stated in units of light fixtures.

**Table A3.4. Facility Class 1: Operational and Training Facilities,
Category Group 14: Land Operational Facilities**

Category Code		Item and Allowance
140		**LAND OPERATIONAL FACILITIES**
141		**OPERATIONAL BUILDING** Facilities which have operations and operational types of activities and equipment including alert hangars and LTA hangars. It excludes ship-related operations buildings (see the 143-series).
	14110	**Airfield Operations Building** A building that houses the flight operations and administrative function of the airfield headquarters. a. The airfield operations building is required to house flight operational and administrative functions of the airfield headquarters. The operations center includes all the functions of flight planning, flight personnel equipment and support rooms, passenger support facilities, and the operations and weather detachments. The airfield headquarters includes administrative space for the commander, military personnel, S-2, S-3, and S-4, safety officer, maintenance officer, and flight surgeon. Also included, unless otherwise provided in other permanent facilities, are an in-flight kitchen and/or snack bar, and a conference and/or briefing room which may also serve as a personnel training or classroom. Because of differences in the aviation missions and the requirements of the facility commanders, the components for an airfield operations building may vary considerably even at Army airfields of comparable size and/or activity. The existence of available permanent facilities will also affect overall space requirements. b. The airfield operations center and/or headquarters may be provided in a separate building or may be combined with the flight control tower and/or fire and rescue station; or, in some cases, may be located in the administrative space or a hangar. c. Actual space requirements will be determined by local appraisal. Projects will be supported by adequate backup data and description to permit MCA Program review by DA and DoD. The number of personnel assigned office space and personnel authorizations will be documented. For project programming guide, the net floor area per building occupant will conform to authorizations contained in TM 5-800-1. Special purpose rooms such as conference, communications, transient waiting, plotting and briefing rooms are not included in the 12 net m^2 [130 net ft^2] per building occupant and will be separately justified by operational requirement data. Personnel requiring locker space, but not assigned office space, will not be included as building occupants in computing net floor area. Special facility requirements, such as Air Weather Service (AWS) and the Flight Surgeon, when provided as direct support at the airfield will be included at the scope authorized below without regard to the number of personnel assigned to the special unit. (1) Air Weather Service: At the facilities provided with direct support AWS Detachments, not less than 139 net m^2 [1,500 net ft^2] will be authorized. (2 Flight Surgeon Facilities: Normally where 30 or more Army aviators are

		assigned to a facility, a flight surgeon will be authorized to care for personnel on flight status and their dependents. Requirements for flight surgeon facilities at variance with those listed below will be justified on an individual basis. (a) At an airfield supporting not more than 25 assigned aircraft, a space of 57.5 net m^2 [620 net ft^2] is authorized. This area will provide: an office, one examining room, an eye lane, an audiometric booth, a toilet, and records and waiting rooms. (b) At an airfield supporting 25 to 50 assigned aircraft, the spaces authorized above, plus an additional examining room, for a total of 74.5 net m^2 [800 net ft^2] is authorized. (c) At an airfield where more than 50 aircraft but less than 200 are assigned, Flight Surgeon and Medical Airmen will be authorized 108 net m^2 [1,160 net ft^2] feet. In addition to the office, two examining rooms, eye lane, toilets, records and waiting room areas, the following will be provided: a minor surgery laboratory room, pharmacy room, separate audiometric booth, ENT (ear, nose, and throat) room, and storage space for supplies and equipment. (d) At facilities supporting more than 200 aircraft, a separate Flight Surgeon Dispensary facility may be authorized. If an existing structure is not suitable for this purpose, then new construction may be authorized. Scope and design of either modifications to existing facilities or design and construction of a new facility will be coordinated with the Surgeon General's Office through HQDA (DAEN-ECE-M). d. For guidance purposes only, the approximate range of gross area required for airfield operations and headquarters facilities (not including the AWS and Flight Surgeon space) is: (1) With not more than 25 assigned miscellaneous aircraft, 204.5 gross m^2 [2,200 gross ft^2]. (2) With not more than 50 assigned miscellaneous aircraft, 279 gross m^2 [3,000 gross ft^2]. (3) At an airfield supporting a division and up to 25 additional miscellaneous aircraft, 492 gross m^2 [5,300 gross ft^2]. (4) At an airfield manned by approximately 60 personnel and which provides interim facilities for Air Force air operations during airlifts, serves other Air Force and Army aviation missions and houses a Medical Evacuation Team, 1,022 m^2 [11,000 ft^2] to 1,858 gross m^2 [20,000 gross ft^2].
	14112	**Aviation Unit Operations Building** A building, or space within a building, used by aviation units for administration and training functions. It is similar to headquarters or administration and supply buildings; however, normally it is located at an airfield. Aviation units, with the exception of direct support maintenance units, require support facilities for training and administration in addition to maintenance shops. Such space will be provided in the hangar, or in a separate building near the hangar. Normally, a separate unit operations building is not provided for miscellaneous aircrafts. These administration space requirements should be provided in the hangar.

	14115	**Weather Station** A building which houses the Representative Weather Observation Station (RWOS), Air Force Weather Service (AWS) operations at Army facilities, and nautical weather services. RWOS is responsible for observing and disseminating current weather conditions to users at an airfield or heliport. AWS service includes observation, recording, reporting, forecasting, and advice to the Army on meteorological conditions. Weather services are also provided for nautical and sea traffic activities from these facilities. Weather stations are also frequently found at RDT&E ranges and other related activities. a. A Representative Weather Observation Station (RWOS) is necessary where an Air Weather Service Detachment is assigned for making continued weather observations critical to the landing and takeoff operations of aircraft. The station should provide an unrestricted view of the runway and surrounding horizons. b. The location and accommodations for the RWOS vary at each airfield depending upon the results of a survey conducted by the Air Force Air Weather Service (AWS). The approved site may be a jointly used control tower, rooms in the tower, a separate building or rooms constructed on an existing building that provides sufficient space for the functions and equipment. For control tower allowance, see category code 13310. As a separate building or as additional rooms, approximately 18.5 m^2 [200 ft^2] is required. This space allowance is in addition to the 139 m^2 [1,500 ft^2] authorized the AWS in the airfield operations building for long range weather forecasting.
149	**Operational Facilities Other Than Building** Facilities other than buildings, such as towers or other structures, used in support of daily activities on the facility, or for practicing tactical operations.	
	14920	**Aircraft Arresting System** An aircraft-arresting system is installed equipment that consists of two main parts: an engaging device and an energy absorber. Examples of engaging devices are barrier nets, disc-supported cables, and remotely raised cables. Absorbing devices include anchor chains, rotary-friction brakes, and rotary-hydraulic units, and can be located aboveground or underground.
	14935	**Blast/Exhaust Deflector** A structure that directs exhaust from engines upward or inward to prevent the erosion of paved and unpaved surfaces, and exhaust interference with taxiways, parking areas, maintenance areas, and nearby buildings. It is also used to channel the effects of blast away from critical areas and to protect nearby facilities.
	14940	**Tower** A reinforced frame (metal, wood, or concrete) facility that supports or contains various types of equipment. Typical uses are for antenna, radar, and drying parachutes.

Table A3.5. Facility Class 1: Operational and Training Facilities, Category Group 17: Training Facilities

Category Code		Item and Allowance		
	17110	**Aircraft Instrument Trainer Building** Aircraft instrument trainer building. See Cat. Code 17112, Flight Simulator Building.		
	17112	**Flight Simulator Building** May be authorized in accordance with the DA-approved basis of issue plan and should conform to the following standard type facilities and scopes:		
		Designation	Gross Area (m^2)	Gross Area (ft^2)
		UH-1 FS (2B24)*	669	[7,200]
		CH-47 FS (2B31)*	1,607	[17,300]
		AH-1 FS (2B33)*	2,127	[22,900]
		UH-60 FS (2B38)*	2,081	[22,400]
		AH-64 FWS (2B40)	2,072	[22,300]
		UH-1/UH-60 (2B24/38)	1,951	[21,000]
		CH-47/AH-1 (2B31/33)	2,648	[28,500]
		CH-47/UH-60 (2B31/38)	2,806	[30,200]
		AH-1/UH-60 (2B33/38)	3,512	[37,800]
		CH-47/AH-1/UH-60 (2B31/33/38)	4,543	[48,900]
		FS = FLT SIMS FWS = FLT and WPN SIM *(Definitive drawings for these facilities may be obtained through HQDA (DAEN-ECE-A).		
	17983	**Army Airfield Training Area** A cleared area used to train soldiers in the fundamentals of selecting and securing a site suitable for takeoffs and landings and parking of rotary-wing aircraft.		

Table A3.6. Facility Class 2: Maintenance Facilities, Category Group 21: Maintenance

Category Code		Item and Allowance
210		**MAINTENANCE**
211		**Maintenance, Aircraft** Facilities and shops for maintenance and repair of rotary- and fixed-wing aircraft. Work may be done on air frames, engines, and other aircraft equipment and components.
	21110	**Aircraft Maintenance Hangar** A facility which provides space for the maintenance and repair of Army aircraft at all levels except depot. Hangars and/or separate adjacent structures are required to conduct the various levels of aircraft maintenance. These are unit (AVUM), intermediate (AVIM) and general support as defined in AR 750-1, *Army Material Maintenance Policies and Retail Maintenance Operations.*

		Hangars will be heated, insulated, adequately lighted for all positions, protected by a fire protection system; and included in them will have compressed air and static grounding systems in the hangar floor areas. Space allowances for hangar facilities are based on the number and type of authorized aircraft, and the maintenance capability of the unit. a. Hangar floor space (also called aircraft maintenance space and aircraft space) is computed by multiplying the number of authorized aircraft times the module area as discussed in Chapter 8; and adding any area required for access/fire lane, and a 1.5 m [5.0 ft] wide perimeter safety corridor. Shop space, which is the hangar space other than hangar floor space, is added to obtain the total hangar space. b. Hangar structures may include space for the following general functional areas when required by the TO&E equipment and the aviation unit mission: aircraft maintenance space and shop space such as technical shops, aircraft parts storage, aircraft weapons repair and storage, unit TO&E storage, flammable storage, maintenance administration, unit administration, unit operations, training and/or briefing facilities. Personal comfort facilities including toilets, showers, locker facilities, and break rooms should be provided. c. Where airfield or heliport activities are limited (low volume of aircraft or aircraft operations) the airfield operations and command functions, normally located in a separate airfield operations building, may be included in a hangar. d. Except when individually justified, or when developing designs for Army National Guard aviation units, authorized areas will not exceed gross square meters (feet) given in Chapter 8.
	21113	**Aircraft Parts Storage** A facility which provides for the storage and issuances of aircraft parts and serves as a supply facility which procures, receives, stocks, and distributes controlled or expendable aircraft components. This category code should be used for stand-alone facilities where the parts storage is physically separate from the remainder of the maintenance activity or to delineate functional areas within the maintenance hangar. Aircraft parts storage at production facilities is classified using category code 44210, Aircraft Parts Storage, Production.
	21114	**Aircraft Maintenance Bay** Area in a hangar where aircraft are parked while being repaired. This category code will be used for stand-alone facilities where the aircraft maintenance bays are physically separate from the remainder of the maintenance activity or to delineate functional areas within the maintenance hangar.
	21116	**Hangar Shop Space** An area in a hangar for activities such as component repair, weapons repair, administration, and flammable storage. This category code will be used for stand-alone facilities where the shop facility is physically separate from the remainder of the maintenance activity, or to delineate functional areas within the maintenance hangar.
	21117	**Avionics Maintenance Shop, Installation** A facility for repair, storage and testing of electronic gear used in aircraft and in aviation maintenance facilities. This category code will be used for stand-alone facilities, at all levels except depot, where the shop is physically separate from the remainder of the maintenance activity, or to delineate functional areas within the maintenance hangar.

	Depot level avionics shops are classified using category code 21740, Avionics Maintenance Shop, Depot.
21120	**Aircraft Component Maintenance Shop** A facility which provides space for engine rebuild, engine and transmission repair, and weights and balances on rotor heads of rotary-wing aircraft. It is normally part of the hangar shop space in category code 21110 Aircraft Maintenance Hangar. This category code will be used for stand alone facilities, at all levels except depot, where the shop is physically separate from the remainder of the maintenance activity, or to delineate functional areas within the maintenance hangar.
21130	**Aircraft Paint Shop** A facility which provides space for the washing, rinsing, paint stripping, corrosion removal, chemical agent resistant coating (CARC), and painting of aircraft at maintenance facilities. This category code will be used for stand-alone facilities where the shop is physically separate from the remainder of the maintenance activity, or to delineate functional areas within the maintenance hangar.
21140	**Aircraft Engine Test Facility** Following engine removal from the aircraft, this enclosed facility provides space to start and operate the aircraft engine while it is mounted on support equipment. This aids in the diagnosis and testing operations performed during extensive engine maintenance or rebuild. This category code will be used for stand alone facilities where the facility is physically separate from the remainder of the maintenance activity, or to delineate functional areas within the maintenance hangar.
21141	**Aircraft Engine Test Structure** Following engine removal from the aircraft, this open-sided facility provides space to start and operate the aircraft engine while it is mounted on support equipment. This aids in the diagnosis and testing operations performed during extensive engine maintenance. This category code will be used for stand-alone facilities where the facility is physically separate from the remainder of the maintenance activity, or to delineate functional areas within the maintenance hangar.
21740	**Avionics Maintenance Shop, Depot** A facility for the repair of electronic gear used in aircraft and in aviation facilities. This category code should be used only at depot level. At other levels of aircraft maintenance, use 21110 or 21117. A minimum of 56 gross m^2 [600 gross ft^2] will be provided in a hangar or in a separate building adjoining an aircraft maintenance apron for an avionics maintenance shop. The facility will be provided with humidity control and suitably equipped to support the repair and storage of electronic gear of aircraft and aviation facilities. Test areas may be shielded to reduce radio frequency interference. The gross area of avionics maintenance shop space should be based on the following allowances: 1-30 Aircraft - 56 m^2 [600 ft^2] (generally located in a hangar shop) 31-50 Aircraft - up to 111 m^2 [1,200 ft^2] based on 2.75 m^2 [30 ft^2] for each additional aircraft above 30 51-100 Aircraft - up to 228 m^2 [2,450 ft^2] based on 2.34 m^2 [25 ft^2] for each additional aircraft above 50

		101-150 Aircraft - up to 321 m^2 [3,450 ft^2] based on 1.86 m^2 [20 ft^2] for each additional aircraft above 100 151-450 Aircraft - up to 432 m^2 [4,650 ft^2] based on 0.37 m^2 [4 ft^2] for each additional aircraft above 150 For over 450 assigned aircraft, specific requirements will be justified. Aggregate space provided for electronics repair in the flight control tower, aircraft maintenance hangars, and for radio parts storage in aircraft unit parts storage buildings, as well as other available post facilities will be taken into account in programming separate new avionics maintenance facilities at an airfield or heliport, to eliminate duplication of existing facilities. However, consideration will be given to economy and efficiency where these functions are performed in one central facility.

Table A3.7. Facility Class 4: Supply Facilities,
Category Group 41: Liquid Fuel Storage, Bulk

Category Code		Item and Allowance
400		**SUPPLY FACILITIES**
410		**LIQUIDS STORAGE, FUEL AND NONPROPELLANTS**
411		**Liquid Fuel Storage, Bulk** Tanks for bulk storage of liquid fuels.
	41120	**Aviation Gas AVGAS Storage, Aboveground** Tanks for bulk storage of non-jet aircraft fuels. These tanks are aboveground type, used for storage of fuel before transfer to an end-use dispensing station. For underground storage, use category code 41122. See category code 124-series for operational fuel storage.
	41121	**Jet Fuel Storage, Aboveground** Tanks for the bulk storage of jet aircraft fuels. These tanks are aboveground type used for storage of fuel prior to its transfer to end-use dispensing stations. For underground storage use category code 41123. See category code 124-series for operational fuel storage.
	41122	**Aviation Gas Storage, Underground** Tanks for the bulk storage of non-jet aircraft fuels. Tanks are located underground. For aboveground storage use category code 41120. See category code 124-series for operational fuel storage.
	41123	**Jet Fuel Storage, Underground** Tanks for the bulk storage of jet aircraft fuels. Tanks are located underground. For aboveground storage use category code 41121. See category code 124-series for operational fuel storage.

442	**Storage, Covered, Installation and Organizational** Three basic types of facilities providing covered storage at the facility and organizational level include: (a) warehouse, storehouse, and garage types of storage completely enclosed by walls, together with heating, sprinkler, and alarm systems as needed; (b) shed storage not completely enclosed by walls, including alarms and other systems; and (c) covered storage for flammables, both warehouse and shed types, removed or set apart from other covered storage according to criteria for storage of flammables.	
	44210	**Aircraft Production Parts Storage, Installation** A facility for storage of parts associated with the maintenance, repair, and production of military aircraft at AMC facilities. Facilities for aircraft parts storage at other aviation facilities should use category code 21113.
452	**Storage, Open, Facilities and Organizational** Open storage areas at facilities and organizational levels. These storage areas are generally graded, drained and surfaced with concrete, asphalt, or other material, to stabilize the supporting ground.	
	45210	**Open Storage Area, Installation** A facility for storage of material and equipment which does not require any protection from the elements. They are generally improved or semi-improved areas which do not provide any cover for the material stored inside. The Defense Reutilization and Marketing Office (DRMO) often uses such facilities for storage of surplus and salvage.

Attachment 4

DEPARTMENT OF DEFENSE
LAND USE COMPATIBILITY GUIDELINES FOR CLEAR ZONE AND ACCIDENT POTENTIAL ZONES

Land Use Category	Compatibility[1] Clear Zone	APZ I	APZ II
Residential			
Single family	NO	NO	YES[2]
2-4 family	NO	NO	NO
Multi-family dwellings	NO	NO	NO
Group quarters	NO	NO	NO
Residential hotels	NO	NO	NO
Other residential	NO	NO	NO
Industrial and Manufacturing [3]			
Food and kindred products	NO	NO	YES
Textile mill products	NO	NO	YES
Apparel	NO	NO	NO
Lumber and wood products	NO	YES	YES
Furniture and fixtures	NO	YES	YES
Paper and allied products	NO	YES	YES
Printing, publishing	NO	YES	YES
Chemicals and allied products	NO	NO	NO
Petroleum refining and related industries	NO	NO	NO
Rubber and miscellaneous plastic goods	NO	NO	NO
Stone, clay and glass products	NO	YES	YES
Primary metal industries	NO	YES	YES
Fabricated metal products	NO	YES	YES
Professional, scientific and controlling instruments	NO	NO	NO
Miscellaneous manufacturing	NO	YES	YES
Transportation, Communications, and Utilities [4]			
Railroad, rapid rail transit (on-grade)	NO	YES[4]	YES
Highway and street rights-of-way	YES[5]	YES	YES
Auto parking	NO	YES	YES
Communication	YES[5]	YES	YES
Utilities	YES[5]	YES[4]	YES
Other transportation, communications, and utilities	YES[5]	YES	YES
Commercial and Retail Trade			
Wholesale trade	NO	YES	YES
Building materials (retail)	NO	YES	YES
General merchandise (retail)	NO	NO	YES
Food - retail	NO	NO	YES
Automotive, marine, aviation (retail)	NO	YES	YES

Apparel and accessories (retail)	NO	NO	YES
Furniture, home furnishing (retail)	NO	NO	YES
Eating and drinking places	NO	NO	NO
Other retail trade	NO	NO	YES
Personal and Business Services [6]			
Finance, insurance and real estate	NO	NO	YES
Personal services	NO	NO	YES
Business services	NO	NO	YES
Repair services	NO	YES	YES
Professional services	NO	NO	YES
Contract construction services	NO	YES	YES
Indoor recreation services	NO	NO	YES
Other services	NO	NO	YES
Public and Quasi-Public Services			
Government services	NO	NO	YES[6]
Educational services	NO	NO	NO
Cultural activities	NO	NO	NO
Medical and other health services	NO	NO	NO
Cemeteries	NO	YES[7]	YES[7]
Non-profit organizations including churches	NO	NO	NO
Other public and quasi-public services	NO	NO	YES
Outdoor Recreation			
Playground's neighboring parks	NO	NO	YES
Community and regional parks	NO	YES[8]	YES[8]
Nature exhibits	NO	YES	YES
Spectator sports including arenas	NO	NO	NO
Golf course [9], riding stables [10]	NO	YES	YES
Water-based recreational areas	NO	YES	YES
Resort and group camps	NO	NO	NO
Entertainment assembly	NO	NO	NO
Other outdoor recreation	NO	YES[8]	YES
Resource Production & Extraction and Open Land			
Agriculture [11]	YES	YES	YES
Livestock farming, animal breeding [12]	NO	YES	YES
Forestry activities	NO	YES	YES
Fishing activities and related services [13]	NO[14]	YES[13]	YES
Mining activities	NO	YES	YES
Permanent open space	YES	YES	YES
Water areas [13]	YES	YES	YES

Notes:

[1] A "YES" or "NO" designation for compatible land use is to be used only for gross comparison. Within each, uses exist where further definition may be needed as to whether it is clear or usually acceptable/unacceptable owing to variations in densities of people and structures.

[2] Suggested maximum density 1-2 dwelling units per acre, possibly increased under a Planned Unit Development where maximum lot covered is less than 20 percent.

[3] Factors to be considered: Labor intensity, structural coverage, explosive characteristics, air pollution

[4] No passenger terminals and no major above ground transmissions lines in APZ I.

[5] Not permitted in graded area, except as noted in Table 3.5.

[6] Low intensity office uses only. Meeting places, auditoriums, etc., not recommended.

[7] Excludes chapels.

[8] Facilities must be low intensity.

[9] Clubhouse not recommended.

[10] Concentrated rings with large classes not recommended.

[11] Includes livestock grazing but excludes feedlots and intensive animal husbandry.

[12] Includes feedlots and intensive animal husbandry.

[13] Includes hunting and fishing.

[14] Controlled hunting and fishing may be permitted for the purpose of wildlife control.

Attachment 5

WIND COVERAGE STUDIES

A5.1. Applicability:

A5.1.1. Army. One factor in the determination of the runway orientation is wind coverage, as discussed in Chapter 3. Runway orientation based on wind coverage for Army airfields will be determined in accordance with the methodology presented in FAA AC 150/5300-13, *Airport Design*, Appendix 1, *Wind Analysis*. The runway orientation should obtain 95 percent wind coverage with a 19.5 kilometer-per-hour (10.5 knot) crosswind. If this coverage cannot be attained, a crosswind runway would be desirable.

A5.1.2. Air Force. One factor in the determination of the runway orientation is wind coverage, as discussed in Chapter 3. Runway orientation based on wind coverage for Air Force airfields will be determined in accordance with the methodology presented in FAA AC 150/5300-13, *Airport Design*, Appendix 1, *Wind Analysis*. Criteria for crosswind runway authorization will be in accordance with criteria presented in AFH 32-1084, *Facility Requirements Handbook*. HQ USAF/XOO must approve authorization for crosswind runways.

A5.1.3. Navy and Marine Corps. Runway orientation for Navy and Marine Corps airfields will be determined in accordance with this attachment. Criteria for the crosswind runway is found in Paragraph A5.6. of this attachment.

A5.2. Objective. This attachment provides guidance on the assembly and analysis of wind data to prepare a wind coverage study to determine runway orientation. It also provides guidance on analyzing the operational impact of winds on existing runways.

A5.3. General. A factor influencing runway orientation is wind. Ideally a runway should be aligned with the prevailing wind. Wind conditions affect all airplanes in varying degrees. Generally, the smaller the airplane, the more it is affected by wind, particularly crosswind components.

A5.3.1. Basic Conditions. The most desirable runway orientation based on wind is the one which has the largest wind coverage and minimum crosswind components. Wind coverage is that percent of time crosswind components are below an acceptable velocity. The desirable wind coverage for an airport is 95 percent, based on the total number of weather observations.

A5.3.2. Meteorological Conditions. The latest and best wind information should be used to carry out a wind coverage study. A record which covers the last five consecutive years of wind observations is preferred. Ascertain frequency of occurrence, singly and in combination, for: wind (direction and velocity), temperature, humidity, barometric pressure, clouds (type and amount), visibility (ceiling), precipitation (type and amount), thunderstorms, and any other unusual weather conditions peculiar to the area.

A5.3.2.1. Usable Data. Use only data which give representative average values. For example, do not consider extremes of wind velocity during infrequent thunderstorms of short duration.

A5.3.2.2. Source of Data. Obtain meteorological data from one or more of the following sources:

A5.3.2.2.1. National Oceanic and Atmospheric Administration, Environmental Data Service

A5.3.2.2.2. National Weather Service

A5.3.2.2.3. Bureau of Reclamation

A5.3.2.2.4. Forest Service

A5.3.2.2.5. Soil Conservation Service

A5.3.2.2.6. Federal Aviation Administration

A5.3.2.2.7. Army Corps of Engineers

A5.3.2.2.8. Navy Oceanographic Office

A5.3.2.2.9. Geological Survey

A5.4. Wind Velocity and Direction. The following are the most important meteorological factors determining runway orientation:

A5.4.1. Composite Windrose. When weather recording stations are located near a proposed site and intervening terrain is level or slightly rolling, prepare a composite windrose from data of surrounding stations.

A5.4.2. Terrain. If intervening terrain is mountainous or contains lakes or large rivers, allow for their effects on wind velocities and directions by judgment, after study of topographical information and available meteorological data.

A5.4.3. Additional Weather Data. Consider wind directions and velocities in conjunction with visibility, precipitation, and other pertinent weather information.

A5.4.4. Wind Distribution. Determine wind distribution to accompany Instrument Flight Rule (IFR) conditions when considering orientation of an instrument runway.

A5.5. Use of Windrose Diagrams. Prepare a windrose diagram for each new runway in the planning stage or to analyze the operational impact of wind on existing runways.

A5.5.1. Drawing the Windrose. The standard windrose (Figures A5.1 and A5.2) consists of a series of concentric circles cut by radial lines. The perimeter of each concentric circle represents the division between successive wind speed groupings. Radial lines are drawn so that the area between each successive pair is centered on the direction of the reported wind.

A5.5.2. Special Conditions. Windrose diagrams for special meteorological conditions, such as wind velocities and directions during IFR conditions, should be prepared when necessary for local airfield needs.

A5.5.2.1. Wind Direction. Use radial lines to represent compass directions based on true north, and concentric circles, drawn to scale, to represent wind velocities measured from the center of the circle.

A5.5.2.2. Calm Wind. Use the innermost circle to encompass calm periods and wind velocities up to the allowable crosswind component for the airfield under consideration.

A5.5.2.3. Computations. Compute percentages of time that winds of indicated velocities and directions occur, and insert them in the segments bounded by the appropriate radial direction lines and concentric wind velocity circles. Express percentages to the nearest tenth, which is adequate and consistent with wind data accuracy. Figure A5.3 displays a completed windrose.

Figure A5.1. Windrose Blank Showing Direction and Divisions [16-Sector (22.5º) Windrose].

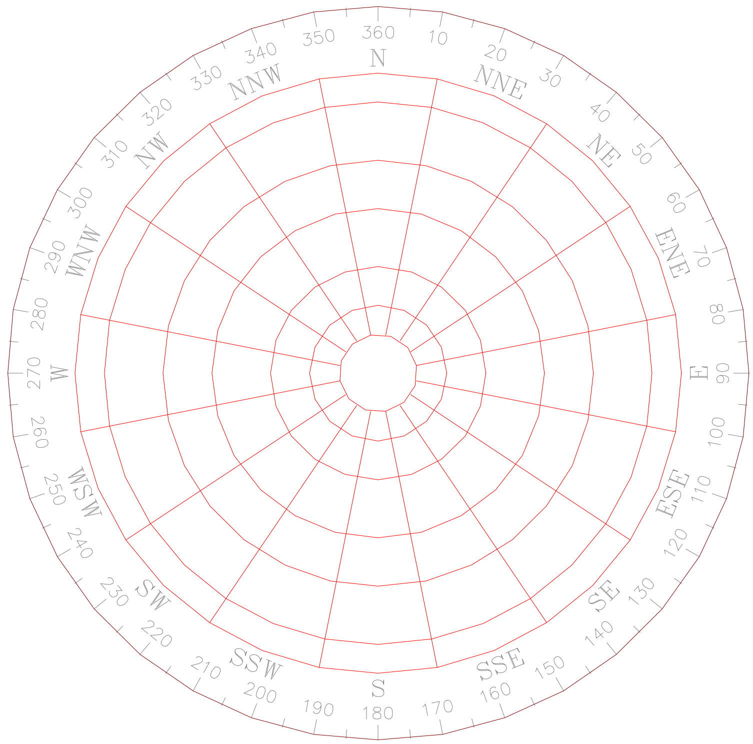


Figure A5.2. Windrose Blank Showing Direction and Divisions [36-Sector (10º) Windrose].

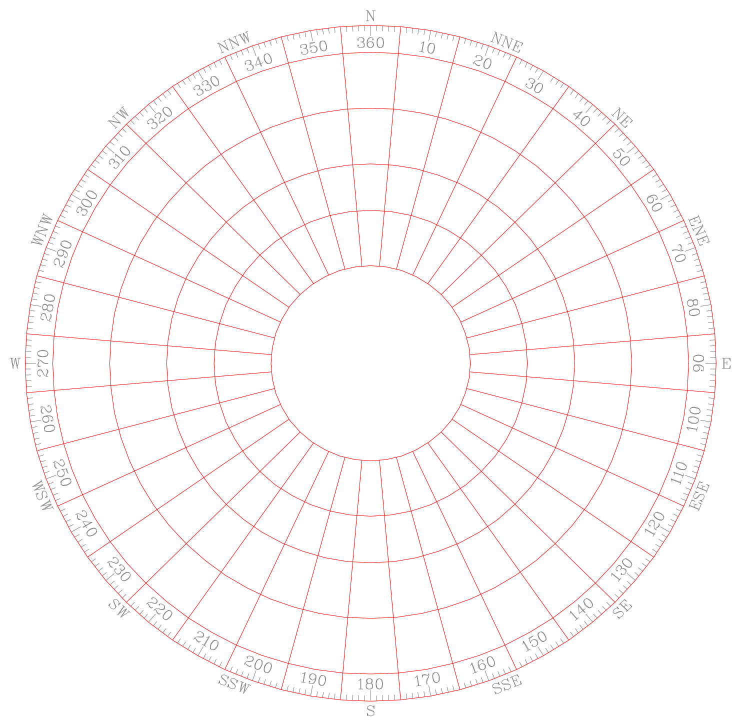
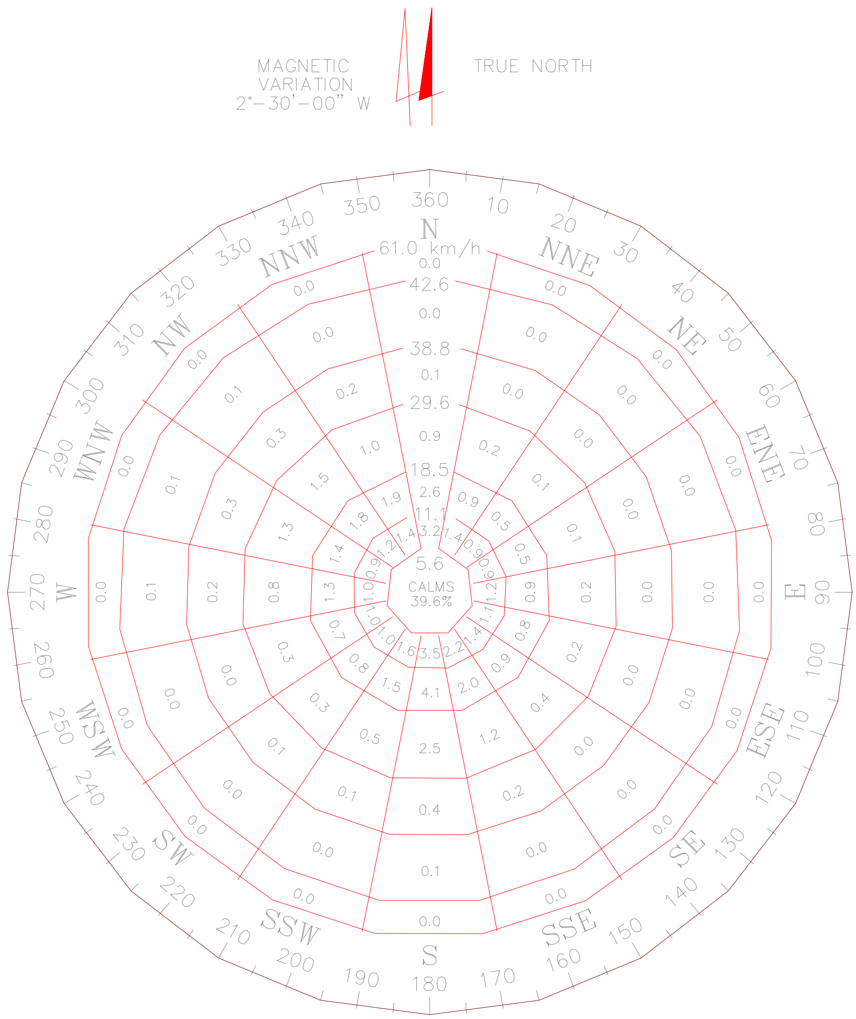


Figure A5.3. Completed Windrose and Wind Velocity Equivalents [16-Sector (22.5 Degree) Windrose].

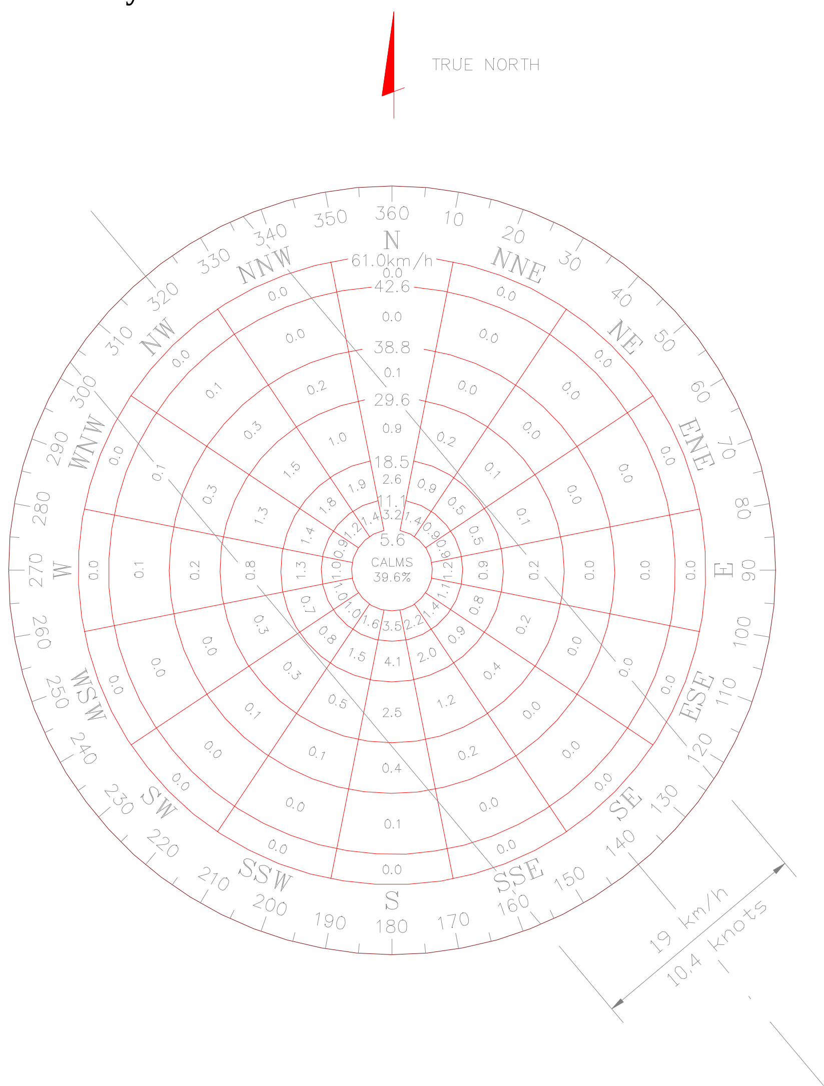


WIND VELOCITY EQUIVALENTS		
KNOTS	KM/H	MPH
3	5.6	2.6
6	11.1	5.2
10	18.5	8.7
16	29.6	13.9
21	38.8	18.3
23	42.6	20.0
33	61.0	28.7

A5.5.2.4. Crosswind Template. A transparent crosswind template is a useful aid in carrying out the windrose analysis. The template is essentially a series of three parallel lines drawn to the same scale as the windrose circles. The allowable crosswind for the runway width establishes the physical distance between the outer parallel lines and the centerline.

A5.5.3. Desired Runway Orientation. For the use of windrose diagrams and crosswind templates in determining desirable runway orientations with respect to wind coverage, see Figure A5.4.

Figure A5.4. Windrose Analysis.



NOTE: A runway oriented 140º—320º (true) would have 3.1 percent of winds exceeding the design crosswind component of 19 km/h.

A5.6. Wind Coverage Requirements for Runways. Determine the runway orientation which provides the greatest wind coverage within the allowable crosswind limits. Place runways to obtain at least 95 percent wind coverage of the maximum allowable crosswind components, as discussed in paragraph A5.6.3. It is accepted practice to total the percentages of the segments appearing outside the limit lines and to subtract this number from 100. For analysis purposes, winds are assumed to be uniformly distributed throughout each of the individual segments. The larger the area or segment, the less accurate this presumption.

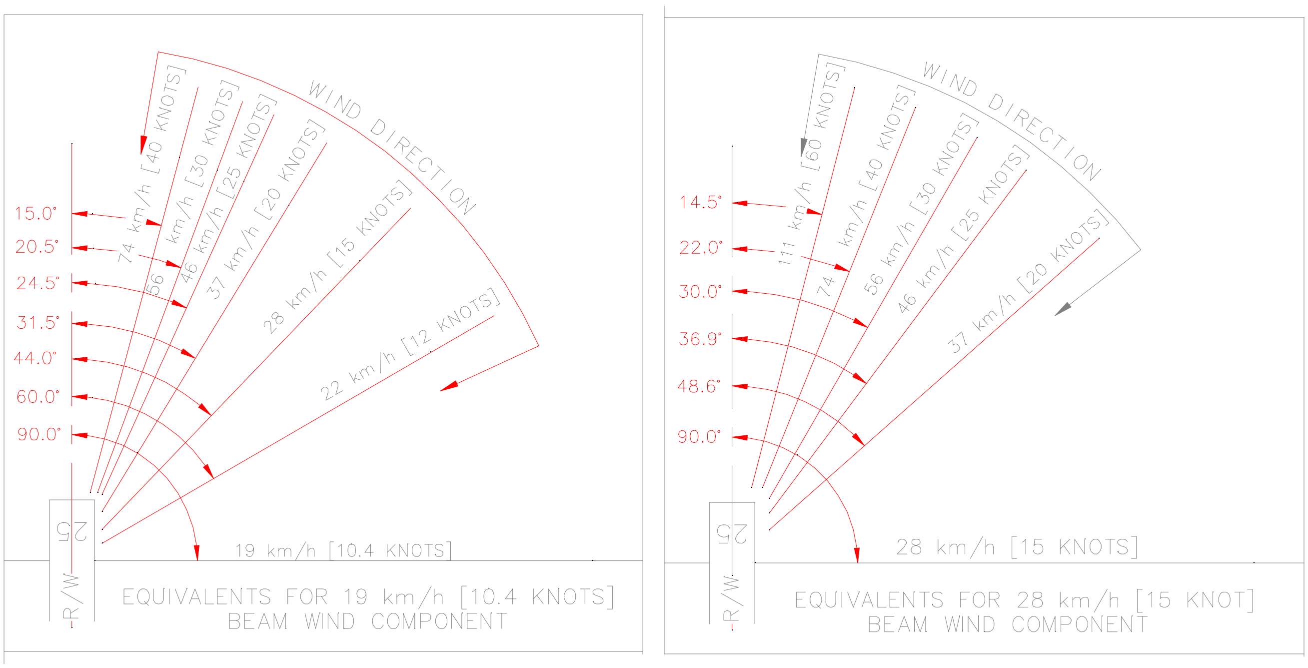
A5.6.1. Primary Runways. Orient a primary runway for the maximum possible wind coverage. See Figure A5.4 for the method of determining wind coverage.

A5.6.2. Secondary Runways. Where wind coverage of the primary runway is less than 95 percent, or in the case of some localities where during periods of restricted visibility the wind is from a direction other than the direction of the primary runway, a secondary (crosswind) runway is required. Normally, secondary runways will not be planned without prior authorization from Naval Air Systems Command. The secondary runway will be oriented so that the angle between the primary and secondary runway centerline is as near 90 degrees as is feasible, considering local site conditions and the need to provide maximum crosswind coverage.

A5.6.3. Maximum Allowable Crosswind Components (Navy Only). Select these components according to type of aircraft, as follows: (1) tricycle gear aircraft, 28.0 kilometers per hour [15.0 knots];and (2) conventional gear aircraft, 19.5 kilometers per hour [10.5 knots].

A5.6.4. Allowable Variations of Wind Direction. See Figure A5.5 for allowable wind directions.

Figure A5.5. Allowable Wind Variation for 19 Kilometer-per-Hour (10.4 Knot) and 28 Kilometer-per-Hour (15 Knot) Beam Wind Components.



Attachment 6

STANDARDS FOR DETERMINING OBSTRUCTIONS
FAR PART 77, PARAGRAPHS 77.13, 77.15, 77.17 and 77.23

The following paragraphs are excerpted from Federal Aviation Regulations, Part 77, Objects Affecting Navigable Airspace:

77.13 Construction or alteration requiring notice.

(a) Except as provided in §77.15, each sponsor who proposes any of the following construction or alteration shall notify the Administrator in the form and manner prescribed in §77.17:

(1) Any construction or alteration of more than 200 feet [60.96 m] in height above the ground level at its site.

(2) Any construction or alteration of greater height than an imaginary surface extending outward and upward at one of the following slopes:

(i) 100 to 1 for a horizontal distance of 20,000 feet [6 096.00 m] from the nearest point of the nearest runway of each airport specified in subparagraph (5) of this paragraph with at least one runway more than 3,200 feet [975.36 m] in actual length, excluding heliports.

(ii) 50 to 1 for a horizontal distance of 10,000 feet 3 048.00 m] from the nearest point of the nearest runway of each airport specified in subparagraph (5) of this paragraph with its longest runway no more than 3,200 feet [975.36 m] in actual length, excluding heliports.

(iii) 25 to 1 for a horizontal distance of 5,000 feet [1 524.00 m] from the nearest point of the nearest landing and takeoff area of each heliport specified in subparagraph (5) of this paragraph.

(3) Any highway, railroad, or other traverse way for mobile objects, of a height which, if adjusted upward 17 feet [5.18 m] for an Interstate Highway that is part of the National System of Military and Interstate Highways where overcrossings are designed for a minimum of 17 feet [5.18 m] vertical distance, 15 feet [4.57 m] for any other public roadway, 10 feet [3.05 m] or the height of the highest mobile object that would normally traverse the road, whichever is greater, for a private road, 23 feet [7.01 m] for a railroad, and for a waterway or any other traverse way not previously mentioned, an amount equal to the height of the highest mobile object that would normally traverse it, would exceed a standard of subparagraph (1) or (2) of this paragraph.

(4) When requested by the FAA, any construction or alteration that would be in an instrument approach area (defined in the FAA standards governing instrument approach procedures) and available information indicates it might exceed a standard of Subpart C of this part.

(5) Any construction or alteration on any of the following airports (including heliports):

(i) An airport that is available for public use and is listed in the Airport Directory of the current Airman's Information Manual or in either the Alaska or Pacific Airman's Guide and Chart Supplement.

(ii) An airport under construction, that is the subject of a notice or proposal on file with the Federal Aviation Administration, and except for military airports, it is clearly indicated that that airport will be available for public use.

(iii) An airport that is operated by an armed force of the United States.

(b) Each sponsor who proposes construction or alteration that is the subject of a notice under paragraph (a) of this section and is advised by an FAA regional office that a supplemental notice is required shall submit that notice on a prescribed form to be received by the FAA regional office at least 48 hours before the start of the construction or alteration.

(c) Each sponsor who undertakes construction or alteration that is the subject of a notice under paragraph (a) of this section shall, within 5 days after that construction or alteration reaches its greatest height, submit a supplemental notice on a prescribed form to the FAA regional office having jurisdiction over the area involved, if -

(1) The construction or alteration is more than 200 feet [60.96 m] above the surface level of its site; or

(2) An FAA regional office advises him that submission of the form is required.

77.15 Construction or alteration not requiring notice.

No person is required to notify the Administrator for any of the following construction or alteration:

(a) Any object that would be shielded by existing structures of a permanent and substantial character or by natural terrain or topographic features of equal or greater height, and would be located in the congested area of a city, town, or settlement where it is evident beyond all reasonable doubt that the structure so shielded will not adversely affect safety in air navigation.

(b) Any antenna structure of 20 feet [6.10 m] or less in height except one that would increase the height of another antenna structure.

(c) Any air navigation facility, airport visual approach or landing aid, aircraft arresting device, or meteorological device, of a type approved by the Administrator, or any appropriate military service on military airports, the location and height of which is fixed by its functional purpose.

(d) Any construction or alteration for which notice is required by any other FAA regulation.

77.17 Form and time of notice.

(a) Each person who is required to notify the Administrator under §77.13 (a) shall send one executed form set (four copies) of FAA Form 7460-1, Notice of Proposed Construction or Alteration, to the Chief, Air Traffic Division, FAA Regional Office having jurisdiction over the area within which the construction or alteration will be located. Copies of FAA Form 7460-1 may be obtained from the headquarters of the Federal Aviation Administration and the regional offices.

(b) The notice required under §77.13 (a) (1) through (4) must be submitted at least 30 days before the earlier of the following dates -

(1) The date the proposed construction or alteration is to begin.

(2) The date an application for a construction permit is to be filed.

However, a notice relating to proposed construction or alteration that is subject to the licensing requirements of the Federal Communications Act may be sent to the FAA at the same time the application for construction is filed with the Federal Communications Commission, or at any time before that filing.

(c) A proposed structure or an alteration to an existing structure that exceeds 2,000 feet [609.60 m] in height above the ground will be presumed to be a hazard to air navigation and to result in an inefficient utilization of airspace and the applicant has the burden of overcoming that presumption. Each notice submitted under the pertinent provisions of Part 77 proposing a structure in excess of 2,000 feet [609.60 m] aboveground, or an alteration that will make an existing structure exceed that height, must contain a detailed showing, directed to meeting this burden. Only in exceptional cases, where the FAA concludes that a clear and compelling showing has been made that it would not result in an inefficient utilization of the airspace and would not result in a hazard to air navigation, will a determination of no hazard be issued.

(d) In the case of an emergency involving essential public services, public health, or public safety, that requires immediate construction or alteration, the 30-day requirement in paragraph (b) of this section does not apply and the notice may be sent by telephone, telegraph, or other expeditious means, with an executed FAA Form 7460-1 submitted within five days thereafter. Outside normal business hours, emergency notices by telephone or telegraph may be submitted to the nearest FAA Flight Service Station.

(e) Each person who is required to notify the Administrator by paragraph (b) or (c) of §77.13, or both, shall send an executed copy of FAA Form 117-1, Notice of Progress of Construction or Alteration, to the Chief, Air Traffic Division, FAA Regional Office having jurisdiction over the area involved.

77.23 Standards for determining obstructions.

(a) An existing object, including a mobile object, is, and a future object would be, an obstruction to air navigation if it is of greater height than any of the following heights or surfaces:

(1) A height of 500 feet [152.40 m] above ground level at the site of the object.

(2) A height that is 200 feet [60.96 m] above ground level or above the established airfield elevation, whichever is higher, within 3 nautical miles [5 559.55 m] of the established reference point of an airport, excluding heliports, with its longest runway more than 3,200 feet [975.36 m] in actual length and that height increases in the proportion of 100 feet [30.48 m] for each additional nautical mile [1852.00 m] of distance from the airport up to a maximum of 500 feet [152.4 m].

(3) A height within a terminal obstacle clearance area, including an initial approach segment, a departure area, and a circling approach area, which would result in the vertical distance between any point on the object and an established minimum instrument flight altitude within that area or segment to be less than the required obstacle clearance.

(4) A height within an en route obstacle clearance area, including turn and termination areas, of a Federal airway or approved off-airway route that would increase the minimum obstacle clearance altitude.

(5) The surface of a takeoff and landing area of an airfield or any imaginary surface established under §77.25, §77.28, or §77.29 (of FAA Part 77). However, no part of the takeoff or landing area itself will be considered an obstruction.

(b) Except for traverse ways on or near an airport with an operative ground traffic control service, furnished by an air traffic control tower or by the airport management and coordinated with the air traffic control service, the standards of paragraph (a) of this section apply to traverse ways used or to be used for the passage of mobile objects only after the heights of these traverse ways are increased by:

(1) Seventeen feet [5.18 m] for an Interstate Highway that is part of the National System of Military and Interstate Highways where over crossings are designed for a minimum of 17 feet [5.18 m] vertical distance.

(2) Fifteen feet [4.57 m] for any other public roadway.

(3) Ten feet [3.05 m] or the height of the highest mobile object that would normally traverse the road, whichever is greater, for a private road.

(4) Twenty-three feet [7.01 m] for a railroad.

(5) For a waterway or any other traverse way not previously mentioned, an amount equal to the height of the highest mobile object that would normally traverse it.

Attachment 7

AIRCRAFT CHARACTERISTICS FOR AIRFIELD-HELIPORT DESIGN AND EVALUATION

Aircraft characteristics, including aircraft dimensions, weights, and other information is available upon request from:

U.S. Army Engineer Waterways Experiment Station
Attn: CEWES-GP-N
3039 Halls Ferry Road
Vicksburg, MS 39180-6199
Telephone: 601-634-2145
FAX: 601-634-3020

U.S. Army Corps of Engineers
Transportation Systems Center (TSMCX)
Attn: CENWO-ED-TX
215 North 17th Street
Omaha, NE 68102-4978
Telephone: 402-221-7262
FAX: 402-221-7261

Attachment 8

JET BLAST EFFECTS

A8.1. Contents. Jet blast affects various operational areas at an airport. Personnel safety is a major concern in terminal, maintenance, and cargo areas.

A8.2. Considerations. The effects of jet blast are far more serious than those of prop wash and must be considered when designing aircraft parking configurations for all military and civil aircraft. These high velocities are capable of causing bodily injury to personnel, damage to airport equipment, or damage to certain pavements and other erodible surfaces.

A8.2.1. Blast Temperatures. High temperatures are also a by-product of jet exhaust. The area exposed to hazardous high temperatures is typically smaller than the area subjected to hazardous blast velocities.

A8.2.2. Blast Velocities. Blast velocities greater than 48 km/h [30 mph] can cause loose objects on the pavement to become airborne and cause injury to personnel who may be a considerable distance behind the aircraft. The layout of aviation facilities must protect personnel from projectiles.

A8.2.3. Minimum Clearances. The minimum clearance from the rear of a jet operating at military power to dissipate the temperature and velocity to levels that will not endanger aircraft personnel and damage other aircraft is referred to as the safe distance. Safe distances are discussed in paragraph A8.5.

A8.2.4. Engine Blast Relationship. Each jet engine has its own footprint of temperature and velocity versus distance. Jet blast relationships for Army, Air Force, and selected civil aircraft may be obtained from the sources listed in Attachment 7. The relationships are in graphical format showing velocity versus distance and temperature versus distance at various power settings. The planner/designer should obtain the jet blast relationship when the effects of jet blast could create a hazardous condition for personnel and equipment.

A8.3. Protection from Jet Blast Effects:

A8.3.1. Blast Deflectors. Equipment such as blast deflectors may be required at locations where continued jet engine runup interferes with the parking or taxiing of aircraft, the movement of vehicles, and the activities of maintenance or aircraft personnel. Additional information on jet blast deflectors is presented in Attachment 9 of this manual.

A8.3.2. Unprotected Areas. Airfield unprotected areas which receive continued exposure to jet blast can erode and cause release of soil, stones, and other debris that can be ingested into jet engines and cause engine damage.

A8.4. Noise Considerations. Protection against noise exposure is required whenever the sound level exceeds 85 dB(A) continuous, or 140 dB(A) impulse, regardless of the duration of exposure.

A8.5. Jet Blast Requirements:

A8.5.1. Parked Aircraft. Criteria in AFH 32-1084, *Facility Requirements Handbook*, state that a minimum clearance is needed to the rear of an engine to dissipate jet blast to less than 56 km/h [35 mph] and not endanger personnel. Velocities of 48 km/h [30 mph] to 56 km/h [35 mph] can occur over 490 meters [1,600 feet] to the rear of certain aircraft with their engines operating at takeoff thrust. However, these velocities decrease rapidly with distance behind the jet engine.

A8.5.2. Taxiing Aircraft. The distance from the rear of the aircraft engine to the wingtip of other aircraft will be:

A8.5.2.1. A minimum of 38 meters [125 feet];

A8.5.2.2. A distance such that jet blast temperature will not exceed 38 ºC [100 ºF];

A8.5.2.3. A distance such that jet blast velocity will not exceed 56 km/h [35 mph].

Attachment 9

JET BLAST DEFLECTOR

A9.1. Overview. Jet blast deflectors can substantially reduce the damaging effects of jet blast on structures, equipment, and personnel. Jet blast deflectors can also reduce the effects of noise and fumes associated with jet engine operation. Erosion of shoulders not protected by asphaltic concrete surfacing can be mitigated by blast deflectors. Blast deflectors consist of a concave corrugated sheet metal surface, with or without baffles, fastened and braced to a concrete base to withstand the force of the jet blast and deflect it upward.

A9.1.1. Location. The deflector is usually located 20 meters [66 feet] to 40 meters [120 feet] aft of the jet engine nozzle, but not less than 15 meters [50 feet] from the tail of the aircraft.

A9.1.2. Size and Configuration. Size and configuration of jet blast deflectors are based on jet blast velocity, and location and elevation of nozzles. Commercially available jet blast deflectors should be considered when designing jet blast protection.

A9.1.3. Paved Shoulders. For blast deflectors placed off the edge of a paved apron, a shoulder is required between the blast deflector and the edge of the paved apron.

Attachment 10

EXPLOSIVES ON OR NEAR AIRFIELDS

A10.1. Contents. All explosives locations, including locations where aircraft loaded with explosives are parked, must be sited in accordance with Department of Defense (DoD) Standard 6055.9, *DOD Ammunition and Explosives Safety Standards,* and with applicable service explosives safety regulations. Explosives site plans, approved through command channels to the DoD, ensure that minimal acceptable risk exists between explosives and other airfield resources. To prevent inadvertent ignition of electroexplosive devices (EEDs), separation between sources of electromagnetic radiation is required. Separation distances must be according to safe separation distance criteria. Grounding requirements, lightning protection, and further considerations for explosives on aircraft are presented below.

A10.2. Separation Distance Requirements. Minimum standards for separating explosives (Explosion Separation Distances and Quantity-Distance (Q-D) Relationships) loaded aircraft from runways, taxiways, inhabited buildings, and other loaded aircraft are established in Chapter 5 of AR 385-64, *Ammunition and Explosives Safety Standards*, for the Army, AFMAN 91-201 *Explosives Safety Standards*, for the Air Force, and NAVSEA OP-5, *Ammunition and Explosives Ashore, Safety Regulations for Handling, Storing, Production, and Renovation*, and NAVAIR 16-1-529, *Electromagnetic Radiation Hazards*, for the Navy and Marine Corps. These documents also establish Quantity-Distance (Q-D) relationships for separating related and unrelated Potential Explosion Site (PES) and explosive and nonexplosive Exposed Sites.

A10.3. Prohibited Zones. Explosives, explosive facilities, and parked explosives-loaded aircraft (or those being loaded or unloaded) are prohibited from being located in Accident Potential Zones I and II and clear zones as set forth in AR 385-64 Chapter 5 and AFMAN 91-201.

A10.4. Hazards of Electromagnetic Radiation to Electroexplosive Devices (EED). General. Electroexplosive devices (EED) on aircraft are initiated electrically. The accidental firing of EED carried on aircraft initiated by stray electromagnetic energy is a possible hazard on an airfield. A large number of these devices are initiated by low levels of electrical energy and are susceptible to unintentional ignition by many forms of direct or induced stray electrical energy, such as radio frequency (RF) energy from ground and airborne emitters (transmitters). Additional sources of stray electrical energy are: lightning discharges, static electricity or triboelectric (friction-generated) effects, and the operation of electrical and electronic subsystem onboard weapon systems. AFMAN 91-201 should be used as a guide in setting up safe separation between aircraft loaded with EED.

A10.5. Lightning Protection. Lightning protection must be installed on open pads used for manufacturing, processing, handling, or storing explosives and ammunition. Lightning protection systems must comply with DoD Standard 6055.9, AFM 88-9/TM 5-811-3 (Chapter 3), *Electrical Design, Lightning and Static Electricity Protection*, AFI 32-1065, *Grounding Systems*, and National Fire Protection Association (NFPA) 780, *Standards for the Installation of Lightning Protection Systems*.

A10.6. Grounding of Aircraft. Aircraft that are being loaded with explosives must be grounded at all times. Air Force grounding of aircraft will be in accordance with AFMAN 91-201 and applicable weapons systems technical orders.

A10.7. Hot Refueling. Hot refueling is the transfer of fuel into an aircraft with one or more engines running. The purpose of hot refueling is to reduce aircraft ground time, personnel and support equipment requirements, and increase system reliability and effectiveness by eliminating system shut-down and restart. All hot refueling locations must be sited in accordance with Department of Defense (DOD) Standard 6055.9, *DoD Ammunition and Explosives Safety Standards*, and applicable service explosives safety criteria.

Attachment 11

COMPASS CALIBRATION PAD (CCP) MAGNETIC SURVEY

A11.1. Contents. This Attachment describes the procedures for performing a magnetic survey for new or existing CCP by a state registered land surveyor. These surveys will determine the following:

A11.1.1. Suitability of a particular site for use as a CCP.

A11.1.2. Variations of the magnetic field within the surveyed area.

A11.1.3. Magnetic declination of the area at the time of the survey.

A11.2. **Air Force, Navy, and Marine Corps Requirements.** This Attachment does not apply to the Navy and Marine Corps other than to provide applicable Navy publications where additional information may be found. USAF designers may use these criteria or the criteria given in Appendix 4 of FAA Advisory Circular 150/5300-13, Airport Design (see paragraph 6.11.1).

A11.3. Accuracy Requirements. For the purpose of this survey, final calculations should be reported to the nearest one minute (1') of arc with an accuracy of ±10 minutes (10'). Typically, magnetic variations can be determined to the nearest 30 minutes (30') of arc by using a conventional transit with a compass. The finer precision needed for these surveys may be obtained by taking a minimum of three readings at each site and then reporting their average. All azimuths must be established by the Global Positioning System (GPS) or Second Order Class II conventional control survey referenced to known positions within the North American Datum of 1983 (NAD83) adjustment network,or convert host nation datum to World Geodetic System 1984 (WGS-84).

A11.4. Preliminary Survey Requirements. Preliminary surveys are conducted for proposed sites to assure that the areas are magnetically quiet and thus suitable for a CCP. They are also used to determine if newly constructed items within the influence zone (see paragraph A11.6) of an existing CCP are causing magnetic interference. When siting a new CCP, the location should be chosen such that all separation distances, as defined in paragraph A11.6, are allowed for to the greatest extent practical. A preliminary magnetic survey will then be conducted to determine if the area is magnetically quiet with no natural or manmade magnetic disturbances. When conducting the preliminary survey, the surveyor must immediately notify the agency requesting the survey of any areas they find that are causing magnetic interferences so they can try to identify and remove the interference and they can also determine if the survey should continue any further at that time. The location of the anomaly can be pinpointed by taking readings at additional points around the disturbed area and finding the location with the highest disturbance. If the magnet anomaly cannot be removed and the site made magnetically quiet, then a new site will need to be chosen. One of the following methods is suggested for a preliminary survey.

A11.4.1. Proton Magnetometer Method. A proton magnetometer can be used by walking over the area and making observations approximately every 6 meters (20 feet.) in a grid pattern covering the site. If the values measured do not vary from any other reading by more than 25 gammas for the whole area, then the site can be considered magnetically quiet.

A11.4.2. Distant Object Method. A distant landmark is selected for siting from the various points, 6 meter [20 foot] grid pattern, of the area being checked. A second distant object at approximately 90 degrees (90º) can also be chosen to increase accuracy. The further away the distant object is, the wider an area of points that can be compared to each other and still obtain the accuracy needed. An 8 kilometer (5 mile) distant object will allow a comparison of magnetic declinations of points that are within a 24 meter (80 foot) wide path in the direction of the distant object; while a 24 kilometer (15 mile) distant object will allow a comparison of points within a 73 meter (240 foot) width, or effectively, the whole CCP site. If the magnetic declinations of the different points vary by more than 12 minutes (12') of arc, then the site is not magnetically quiet.

A11.4.3. Reciprocal Observation Method. Several scattered points are selected and marked in the area to be tested. The transit will be set up over one central point and the magnetic azimuth to all of the other points will be determined and recorded. Then the transit will be set up over all the other points and a back azimuth to the central point will be determined and recorded. If there are no magnetic disturbances, then the original azimuth and the back azimuth should be the same for each of the points checked. If there is a difference between the azimuth and back azimuth of any of the points, which is greater than 12 minutes (12') of arc, then the site is not magnetically quiet.

A11.5. Magnetic Survey Requirements. The magnetic survey for the CCP is an airfield engineering survey. AR 95-2 requires that airfield engineering surveys be scheduled on recurring five-year cycles. (The Navy and Marine Corps require annual engineering surveys). This cycle is operationally important, since magnetic north not only varies at different locations on the earth, but it also physically changes as a function of time. It is an operational requirement to calibrate aircrafts' compass correction factors on a regular basis because of these changes. Additionally, the magnetic survey assures that the aircraft will be in a "magnetically quiet zone" which is essential to assure proper calibration of its compass. The magnetic survey for the compass calibration pads must be performed in accordance with paragraph A11.5.

A11.6. Magnetic Survey Procedures. These procedures consist of the magnetic field survey which is used to determine the magnetic declination of a site and the magnetic direction survey which is used to layout the CCP markings. Both a magnetic field survey and a magnetic direction survey of the CCP will be performed every five years or sooner as required by the controlling agency and when magnetic influences have occurred within or adjacent to the CCP. Magnetic influences are considered to be additions of power lines, installation of items containing ferrous metals, or similar activities within an influencing distance of the CCP as defined in paragraph A11.6.

A11.6.1. Magnetic Field Survey (Variation Check). This survey is to measure the magnetic declination within the CCP area. The surveyor will be required to certify that the variations of the magnetic field are within the allowable range and to provide the average magnetic declination of the area. The direction of the horizontal component of the Earth's magnetic field (magnetic declination) measured at any point within a space between 0.6 meters (2 feet) and 1.8 meters (6 feet) above the surface of the CCP, and extending over the entire area of the CCP, must not differ by more than 12 minutes (12') of arc from the direction measured at any other point within this area. All raw data, intermediate computations, and final results will be submitted in a clear, neat, and concise format. The surveyor will accurately layout a 6 meter by 6 meter (20 foot by 20 foot) grid with its center point coincident with the center point of the CCP. The grid will be laid out so the entire area of the CCP plus a minimum of 6 meters (20 feet) outside each edge of the CCP is covered. The grid may be laid out in any direction, but a true north or a magnetic north direction is preferred, since it will simplify the azimuth calculations and allow immediate recognition of points that are outside the allowable declination limits. In any case, the surveyor will have to determine the true azimuth of the grid layout by standard surveying procedures so the azimuth and declination of each point can be determined. After the grid is laid out, the surveyor will check the declination of all the grid points by one of the following methods:

A11.6.1.1. Distant Object Method. A distant landmark is selected for siting from the various points of the area being checked. A second distant object at approximately 90 degrees (90º) can also be chosen to increase accuracy. The further away the distant object is, the wider an area of points that can be compared to each other and still obtain the accuracy needed. An 8 kilometer (5 mile) distant object will allow a comparison of magnetic declinations of points that are within a 24 meter (80 foot) wide path in the direction of the distant object; while a 24 kilometer (15 mile) distant object will allow a comparison of points within a 73 meter (240 foot) width, or effectively, the whole CCP site. If a distant object cannot be chosen far enough away to accurately compare the whole sight (at no time will a distant object be closer than 8 kilometer [5 mile]), then corrections for the eccentricity would have to be made. If the grid were laid out so its center was in line with the distant object and an equal number of points were laid out on either side of this centerline, then this eccentricity would automatically be corrected when the azimuths are averaged. But the points can only be compared to other points within the allowable path width when checking for disturbances in the declinations, unless corrections for the eccentricities are allowed for. The average value is then computed, adjusting for eccentricities if necessary, and reported as the site declination.

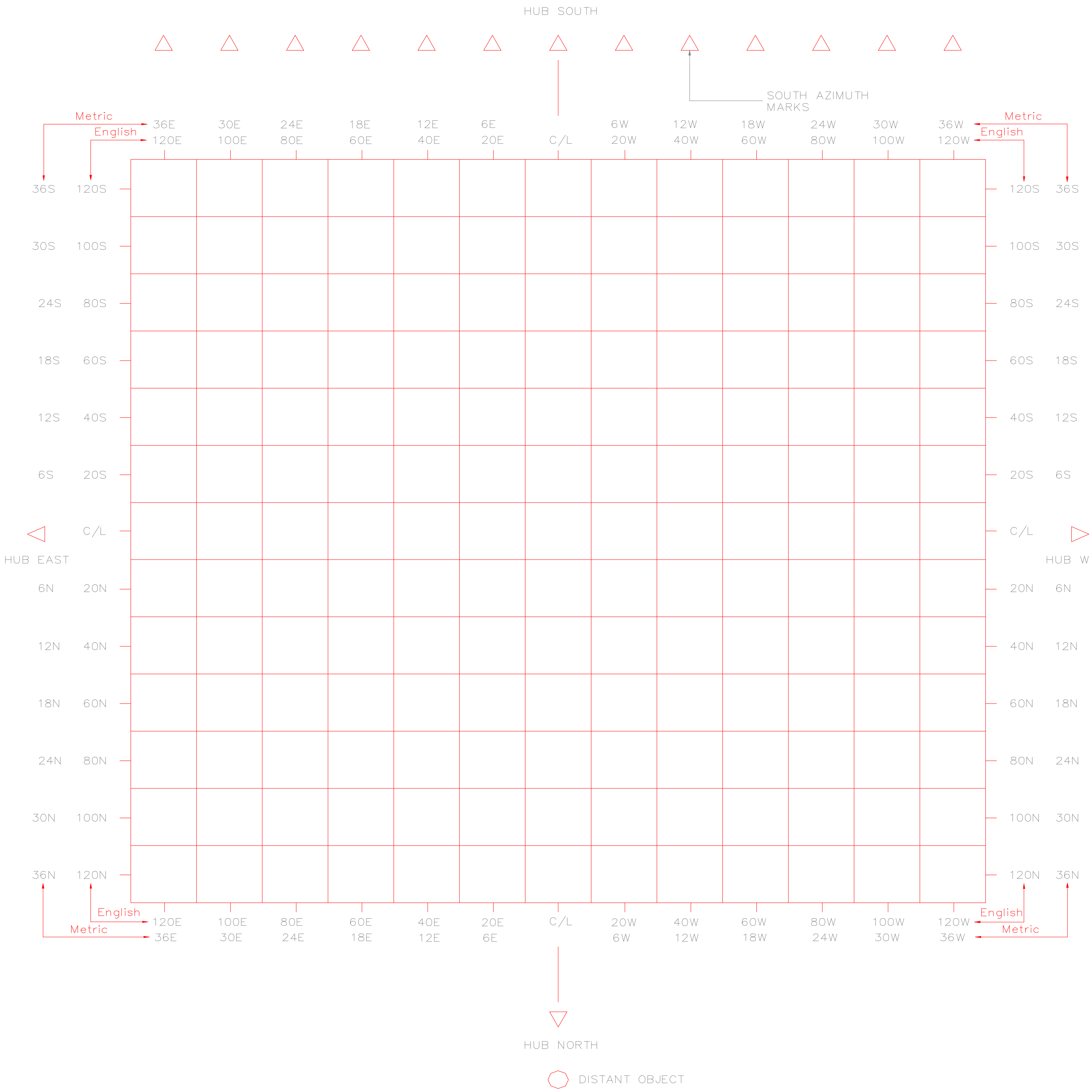
A11.6.1.2. Distant Hub Method. After the grid is laid out, additional hubs are laid out a minimum of 90 meters (300 feet) in all four directions from the center point of the grid and designated as "Hub N," "Hub S," "Hub E," and "Hub W." "South Azimuth Marks" are placed perpendicular to the "Hub S," 6 meters (20 feet) apart, and coincident to the grid layout, as shown in Figure A11.1. These azimuth marks will then be used for sighting and taking declination readings. After the grid and azimuth marks are accurately set, the surveyor will set up and level his transit over the center point and sight it on the "Hub S" mark and zero the vernier. The surveyor then must release the compass needle and turn the transit to center it on the compass needle while all the time tapping the compass to minimize friction effects. A reading will be taken here (to the nearest one minute (1')), then deflect the compass needle with a small magnet, realign the transit with the compass and take a third reading. These three readings are averaged to provide the declination for this spot. The surveyor will accurately record the time to the nearest minute for the first and third reading. After the readings are completed for the center point (which will be used for reference), the surveyor will then set up the transit over the other points of the grid and follow the same steps as above while sighting at the appropriate "Azimuth Mark" and determine the declination of each of these grid points. Approximately every 20 to 30 minutes, or any time a reading turns out to be outside the allowable 12 minutes (12') of arc, the surveyor must re-setup over the center point and take new readings to check for diurnal changes in the declination. If readings are found to be outside the allowable 12 minutes (12') of arc, after making corrections for diurnal changes, the surveyor will set up at the bad point and re-check it to see if the results are repeatable. If all the readings are within the required 12 minutes (12') after the surveyor has made diurnal corrections, he then can average these readings and determine the site declination.

A11.6.2. Magnetic Direction Survey. This survey is to check the layout of the markings at an existing CCP or to lay out the markings for a new CCP.

A11.6.2.1. New CCP. For new CCP , the surveyor will determine the center of the pad and mark it with a bronze surveying marker accurately grouted in place. This point will be stamped "Center of Calibration Pad." After the center point is located and set, the surveyor will accurately locate and set the following control points and pavement markings in a similar manner. See Figure A11.2 for greater detail of the control point layout.

A11.6.2.1.1. True North-South. A north and south control point will be set on a "true north-south" line established through the center of the calibration pad marker. The north-south control points must be located radially from the center of the compass calibration pad at a distance of 9 meters (30 feet). These points will be stamped "N_T" for the north point and "S_T" for the south point. The markers will also be stamped with "True North (South) - Established 'Day' 'Month' 'Year.'"

Figure A11.1. Magnetic Field Survey Sheet.



A11.6.2.1.2. Magnetic North. A magnetic north control point will set on the "magnetic north azimuth" as determined by the magnetic survey. The magnetic north control point will be located radially from the center of the compass calibration pad at a distance of 12 meters (40 feet). This point must be marked on the pavement with a "N_m" above the point at 12.3 meters (41 feet) radially from the center point and " 'Month' 'Year' " below the point at 11.7 meters(39 feet) radially from the centerpoint. The date will reflect when the magnetic north was established by a field magnetic survey. The markings will consist of 300 millimeter (12 inch) high block numerals with 75 millimeter- (3-inch-) wide orange point stripes. The bronze marker will be stamped with "Magnetic North - Established 'Day' 'Month' 'Year'" and "Declination - 'Degrees' 'Minutes'."

A11.6.2.1.3. Compass Rose Control Points. Twenty-four (24) control points will be provided at 7.5 meters (25 feet) radially from the centerpoint beginning at true north and then every 15 degrees (15º). These points will consist of bronze markers accurately grouted in place. Each of these points will be stamped with their true azimuth (for example $15N_T$).

A11.6.2.1.4. Magnetic Compass Calibration Stripes. These stripes are set at magnetic directions from the corresponding true compass rose control point at every 15 degrees (15º). A 150 millimeter- (6-inch-) wide orange stripe will be painted radially from the center of the pad for 7.5 meters (25 feet) for each of the 24 compass rose control points. Each stripe will be bordered by a 40 millimeter- (1½-inch-) wide white stripe. At a distance of 8.2 meters (27 feet) from the center of the pad, in white 600 millimeter- (24-inch-) high block numerals with 0.15-meter- (6-inch-) wide orange paint stripes, paint the azimuth of each stripe as measured from magnetic north. Each orange numeral will be bordered by a 40 millimeter- (1½-inch-) wide white stripe. The layout of the compass rose is detailed in Figure A11.2.

A11.6.2.2. Existing CCPs. For existing CCP, the surveyor will be required to check the alignment of the magnetic north control point and adjust it if necessary. If the average magnetic declination, as determined by a magnetic field survey described in paragraph A11.5.1. above, differs by more than 0.5 degrees (30') from what is marked on the CCP, then the CCP must be re-calibrated. First, all magnetic markings must be removed from the pavement. Then the magnetic north control point marker must be removed and reset to the correct position as described above for a new CCP. The compass rose markings are then laid out and marked as described above for a new CCP.

A11.7. Siting Considerations:

A11.7.1. Separation Distances. To meet the magnetically quiet zone requirements and prevent outside magnetic fields from influencing the aircraft compass calibration, all efforts possible will be taken to make sure that the center of the pad meets the minimum separation distance guidelines.

A11.7.1.1. The minimum recommended separation distances are as follows:

A11.7.1.1.1. 70 meters (230 feet) to underground metal conduits, metal piping (including reinforced concrete pipes), or similar items.

A11.7.1.1.2. 85 meters (280 feet) from the edge of any pavement that is not specifically designed and built for CCP operations.

A11.7.1.1.3. 150 meters (500 feet) to underground alternating current (AC) power lines (including runway/taxiway edge lighting).

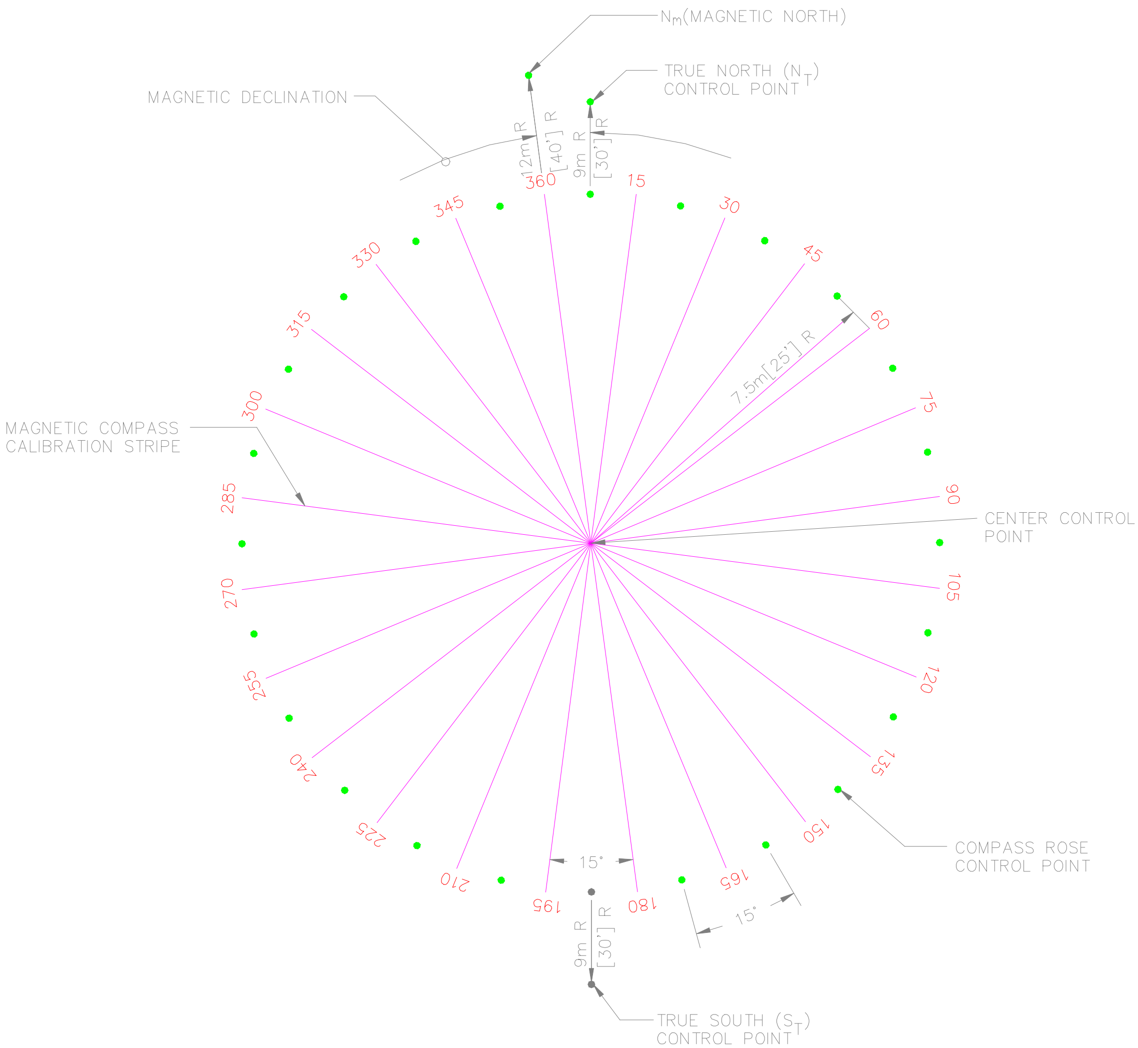
A11.7.1.1.4. 185 meters (600 feet) to overhead steam lines; overhead conduits or metal piping; overhead AC power lines; any AC equipment; the nearest edge of any railroad track; the nearest fire hydrant; and the nearest portion of any building.

A11.7.1.1.5. 300 meters (1,000 feet) to any direct current (DC) power lines or equipment (including any underground or above ground telephone lines).

A11.7.1.2. Navy and Marine Corps. For the Navy and Marines, the criteria for separation distances for CCP is given in MIL HDBK-1021/1, *General Concepts for Airfield Pavement Design*.

A11.7.2. Checking Site. Each proposed site for a CCP must be checked for magnetic influence to ensure that the area is magnetically quiet regardless of adherence to separation distances.

Figure A11.2. Layout of Compass Rose.



Attachment 12

TIEDOWNS, MOORING, AND GROUNDING POINTS

A12.1. Types of Equipment:

A12.1.1. Mooring and Grounding Point. A mooring and grounding point is a mooring casting with a grounding rod attached. Aircraft mooring and grounding points are used to secure parked aircraft and also serve as electrodes for grounding connectors for aircraft. Combined mooring and grounding points have previously been used by the Army, but are not currently used as they do not meet mooring and grounding design loads required by TM 1-1500-250-23, *General Tie-Down and Mooring on all Series Army Models AH-64, UH-60, CH-47, UH-1, AH-1, OH-58 Helicopters.*

A12.1.2. Mooring Point. A mooring point is a mooring casting without a grounding rod attached, used to secure parked aircraft. Mooring points are used by the Army.

A12.1.3. Static Grounding Point. A static grounding point is a ground rod attached to a casting. The casting protects the ground rod but does not provide mooring capability. Static grounding points are used by the Army in aprons and hangars.

A12.1.4. Tiedown. A tiedown is a 3-meter [10-foot] rod with a closed-eye bend. The tiedown is intended to secure parked aircraft but may also serve as an electrode connection for static grounding of aircraft. Tiedowns are used by the Air Force.

A12.1.5. Tiedown Mooring Eye. A tiedown mooring eye is a mooring casting with a grounding rod attached. They are similar to the mooring and grounding point discussed above. Tiedown mooring eyes are used by the Navy and Marine Corps.

A12.2. Mooring Points for Army Fixed- and Rotary-Wing Aircraft:

A12.2.1. Type. A mooring point consists of a ductile iron casting, as shown in Figure A12.1. The mooring casting is an oval-shaped casting with a cross-rod to which mooring hooks are attached.

A12.2.2.. Design Load. Unless specifically waived in writing by the facility Commander, all new construction of Army aircraft parking aprons will include aircraft mooring points designed for a 67,800 Newtn [15,250 pound] load, as specified in TM 1-1500-250-23 and applied at 19.15 degrees (19.15º) from the pavement surface, as illustrated in Figure A12.2.

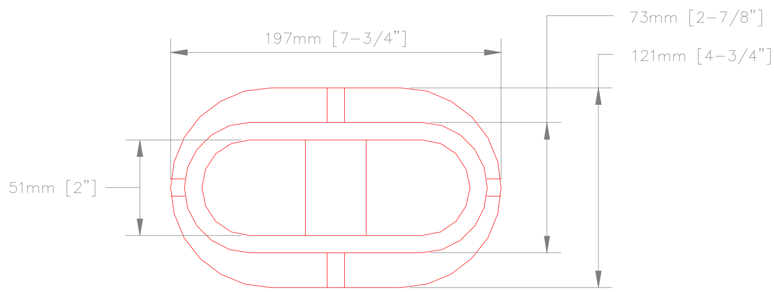
A12.2.3. Layout:

A12.2.3.1. Fixed-Wing Aprons. Mooring points should be located as recommended by the aircraft manufacturer or as required by the base.

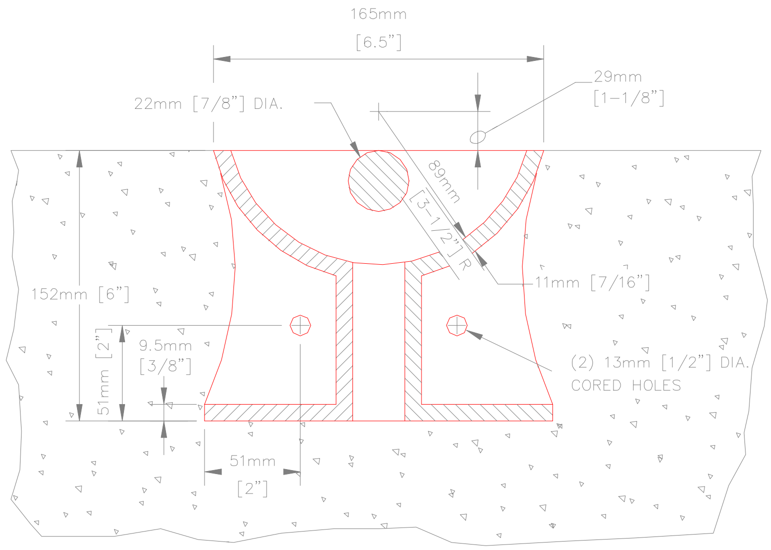
A12.2.3.2. Rotary-Wing Aprons:

A12.2.3.2.1. Number of Moored Parking Spaces. Moored parking spaces will be provided for 100 percent of the authorized aircraft. The combined total of apron parking space and hangar parking space should provide sufficient parking for wind protection for all facilities' authorized aircraft and typical transient aircraft. Additional parking spaces with mooring points may be added as necessary to ensure wind protection for all aircraft. The locations of these additional mooring points can be on pavements other than parking aprons. Prepared turf surfaced areas are acceptable for rotary-wing aircraft mooring locations.

Figure A12.1. Army Mooring Point.



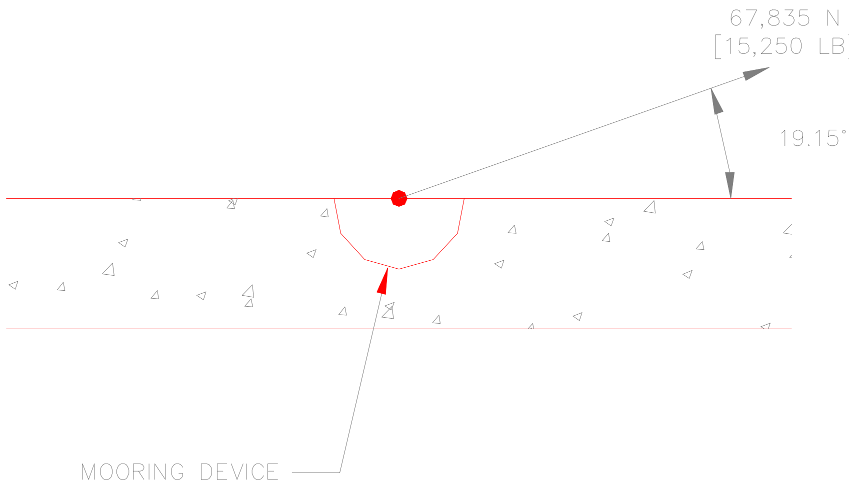
PLAN
N.T.S.



SECTION
N.T.S.

NOTE
MOORING DEVICE TO BE CAST
IN DUCTILE IRON 80-55-06
OR EQUAL.

Figure A12.2. Army Load Testing of Mooring Points.



NOTES

1. MOORING TESTS SHOULD BE ACCOMPLISHED USING A HYDRAULIC RAM OR SIMILAR DEVICE AND AN APPROPRIATE REACTION (HEAVY VEHICLE, ETC.) THAT IS CAPABLE OF APPLYING A TENSILE LOAD OF 71,172 N [16,000 LB]

2. THE LENGTH OF MOORING CHAIN AND CONNECTING SHACKLE SHOULD BE SELECTED IN SUCH A WAY THAT AN ANGLE OF 19.15° FROM THE PAVEMENT SURFACE (SEE ABOVE FIGURE) CAN BE MAINTAINED DURING LOAD TESTING.

3. APPROPRIATE SAFETY PRECAUTIONS SHOULD BE TAKEN AT ALL TIMES DURING LOAD TESTING OPERATIONS.

4. THE MOORING POINTS SHOULD BE LOADED IN 1,130 kg [2,500 LB] INCREMENTS UP TO 44,482 N [10,000 LB] AND IN 4,448 N [1000 LB] INCREMENTS UP TO 71,172 N [16,000 LB] WITH EACH LOAD INCREMENT HELD FOR AT LEAST 60 SECONDS.

5. TO PASS TEST REQUIREMENTS, MOORING POINTS SHALL NOT DEFORM PERMANENTLY UNDER 71,172 N [16,000 LB] LOAD.

A12.2.3.2.2. Number of Mooring Points at Each Parking Space. Each rotary-wing aircraft parking space location will have six mooring points. Although some rotary-wing aircraft only require four mooring points, six may be installed to provide greater flexibility for the types of rotary-wing aircraft which can be moored at each parking space. The largest diameter rotor blade of the facilities' assigned aircraft will be used for locating the mooring points within the parking space. The allowable spacing and layout of the six mooring points is illustrated in Figure A12.3. Parking space width and length dimensions are presented in Table 6.2 of Chapter 6.

A12.2.3.2.3. Mooring Points on a Grid Pattern. A 6 meter by 6 meter [20 foot by 20 foot] mooring point grid pattern throughout the apron for mass aircraft parking aprons will not be authorized, unless economically and operationally justified in writing by the installation Commander. Figure A12.4 provides the recommended pavement joint and mooring point spacing should grid pattern mooring be utilized.

Figure A12.3. Army Rotary-Wing Allowable Mooring Point Spacing.

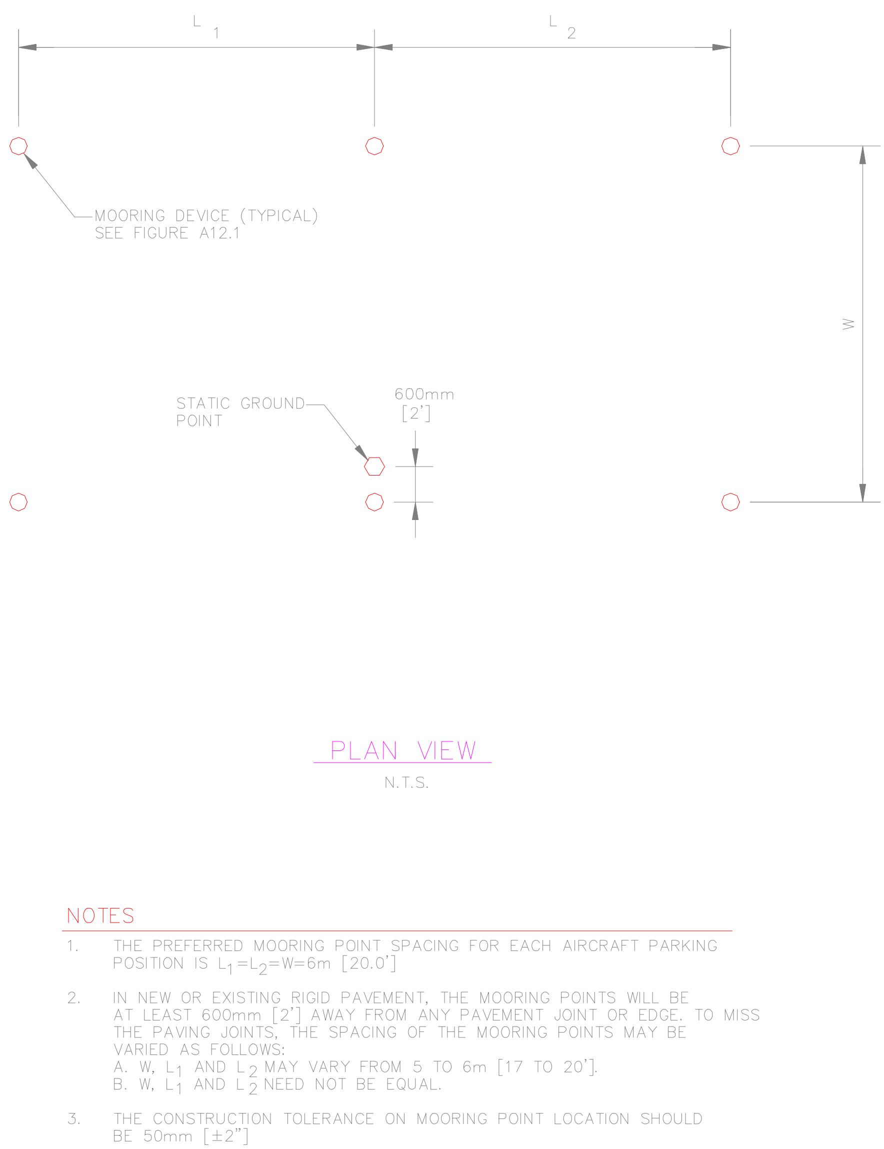
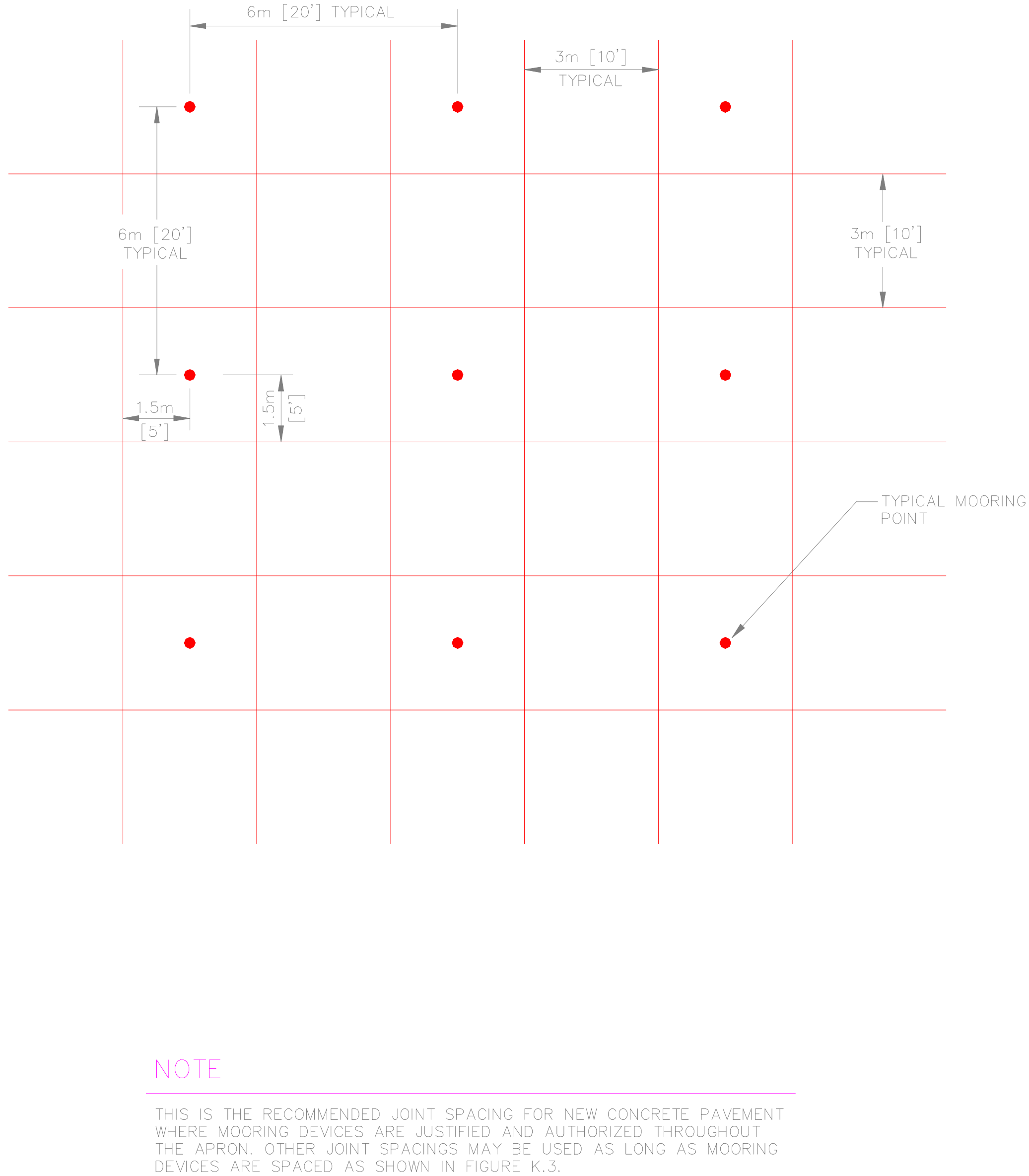


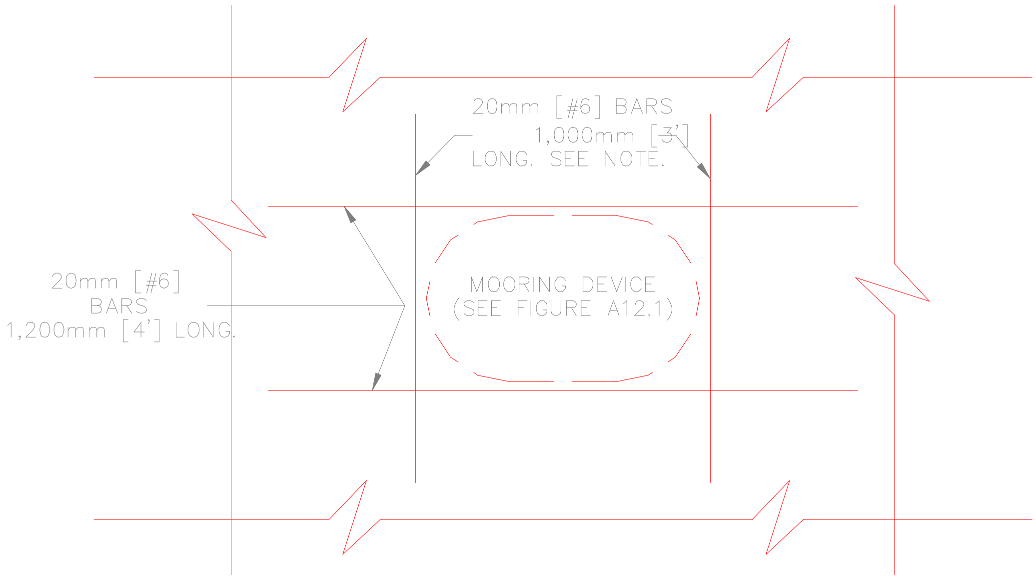
Figure A12.4. Army Rotary-Wing Mooring Points Layout.



A12.2.4. Installation.

A12.2.4.1. Mooring Points for New Rigid Pavement Equal to or Greater Than 150 Millimeters [6 Inches] Thick. Mooring points for new rigid pavements will be provided by embedding the mooring devices in fresh Portland cement concrete (PCC). The layout of points is shown in Figure A12.3 with mooring points at least 600 millimeters [2 feet] from the new pavement joints. This spacing will require close coordination between the parking plan and the jointing plan. Mooring points should be located a minimum of 600 millimeters [2 feet] from any pavement edge or joint and should provide proper cover for the reinforcing steel. Reinforcing bars should be placed around the mooring points as illustrated in Figure A12.5.

Figure A12.5. Slab Reinforcement for Army Mooring Point.



PLAN VIEW

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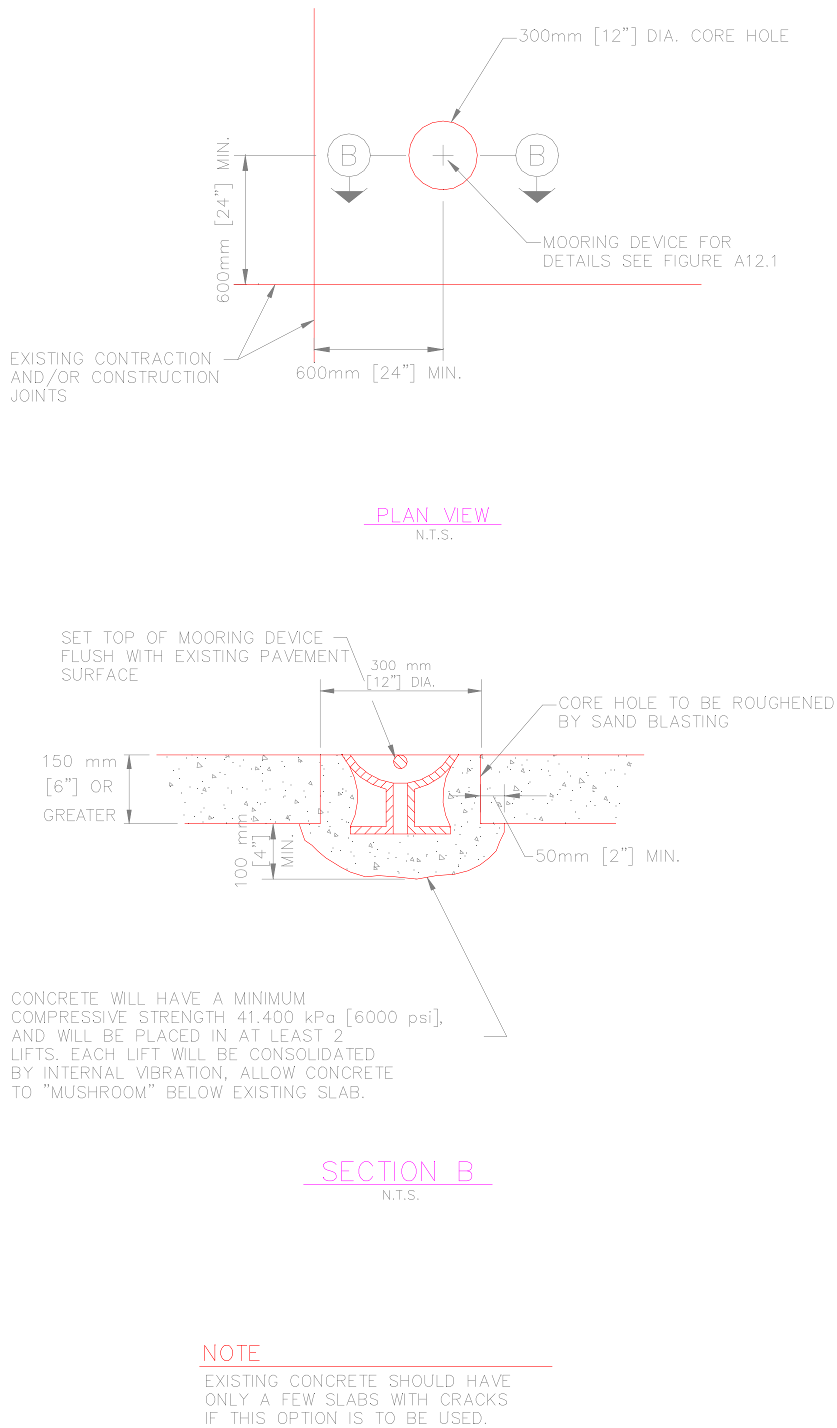
NOTES

1. THESE #6 REINFORCING BARS SHOULD BE PLACED 75mm [3"] FROM MOORING DEVICE AND 75mm [3"] BELOW PAVEMENT SURFACE.

2. THE ENDS OF REINFORCING BARS SHOULD BE PLACED 75mm [3"] FROM PAVING JOINTS TO PROVIDE COVER.

A12.2.4.2. Mooring Points for Existing Rigid Pavement Equal to or Greater Than 150 Millimeters [6 Inches] Thick and In An Uncracked Condition. The following method should be used to provide mooring points for existing rigid pavement that is in an uncracked condition. The pavement should have only a few slabs with random cracks and must not exhibit "D" cracking. Mooring points should be provided by core-drilling a 300 millimeter [12 inch] diameter hole through the pavement and installing a mooring point as illustrated in Figure A12.6.

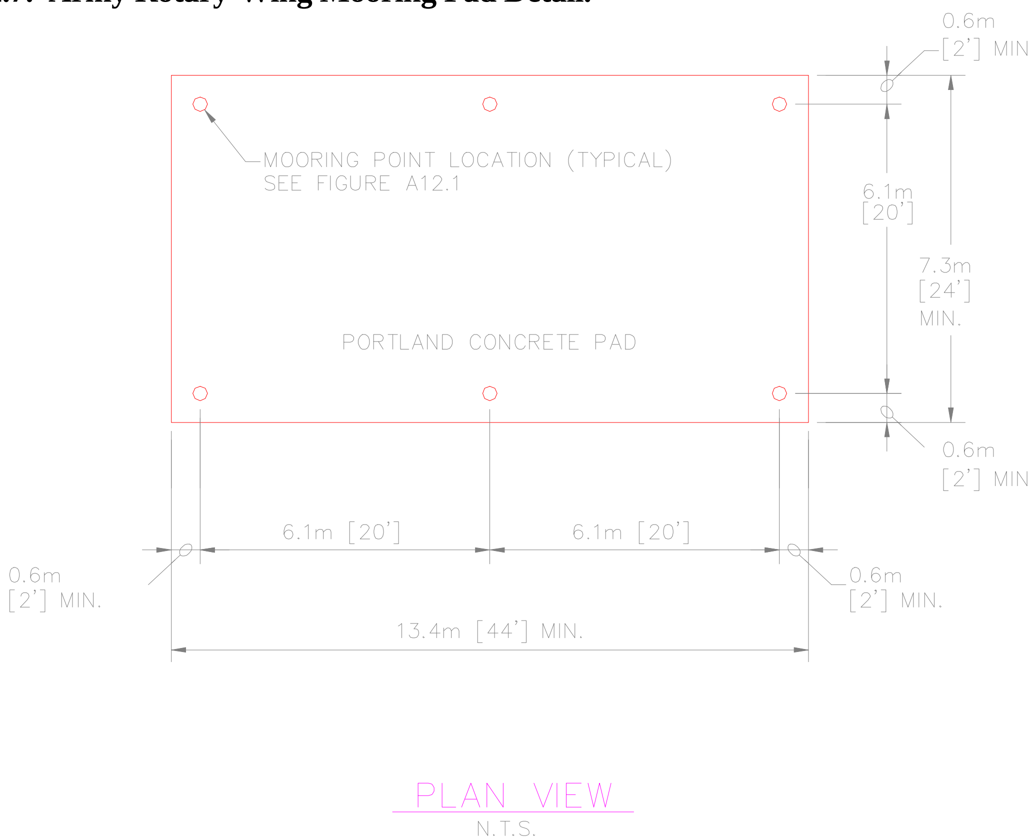
Figure A12.6. Mooring Point for Existing Rigid Pavement for Pavement Thickness Greater Than 150 Millimeters (6 Inches).



A12.2.4.3. Mooring Points for Areas Not Covered Above. The following installation options should be used to provide mooring points for rotary-wing aircraft parked on the following pavements: existing rigid pavement less than 150 millimeters [6 inches] thick; existing rigid pavement in a cracked or deteriorated condition; new or existing flexible pavement; turfed areas; and other areas where appropriate.

A12.2.4.3.1. Installation Option 1, Mooring Pad. This option is the preferred installation method, and allows for placement of a new concrete pad with a minimum thickness of 200 millimeters [8 inches]. The size of the pad should be a minimum of 7.3 meters [24 feet] wide by 13.4 meters [44 feet] long. The length and width may be increased to match the existing concrete joint pattern. The mooring pad, with six mooring points, is illustrated in Figure A12.7. The mooring devices should be installed as illustrated in Figure A12.1, and the concrete reinforced as illustrated in Figure A12.5.

Figure A12.7. Army Rotary-Wing Mooring Pad Detail.



NOTES

1. THIS MOORING PAD IS THE PREFERRED METHOD OF PROVIDING MOORING POINTS IN GRASSED AREAS AND IN FLEXIBLE PAVEMENTS. FOR RIGID PAVEMENT APPLICATIONS, THE SIZE OF THE PAD SHOULD BE INCREASED TO MATCH THE EXISTING JOINT PATTERN.

2. THICKNESS OF THE PAD SHOULD BE DESIGNED TO CARRY THE EXPECTED AIRCRAFT LOADS, BUT NOT LESS THAN 200mm [8"].

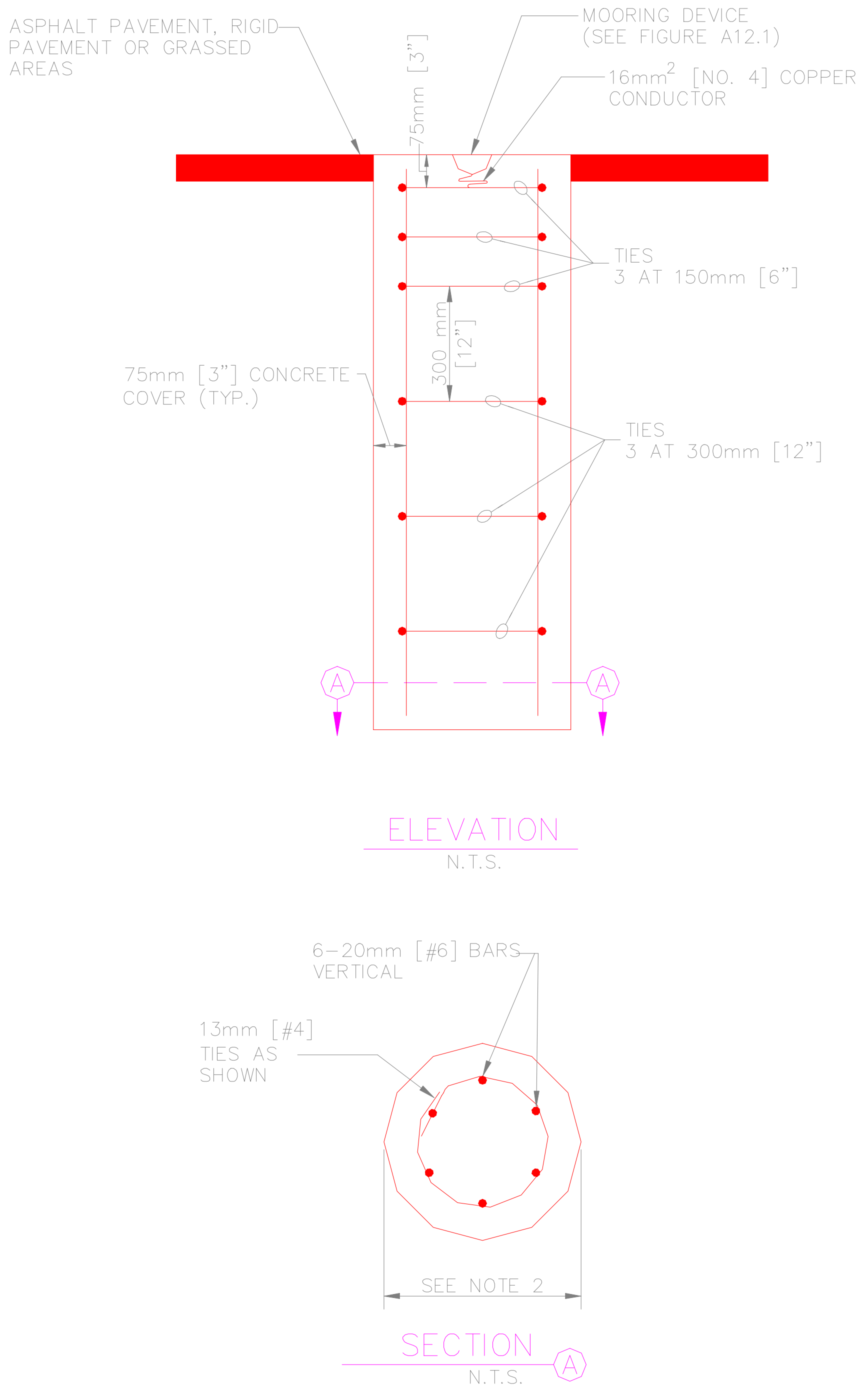
3. THE SLAB SHOULD BE DESIGNED AS A REINFORCED SLAB SO THAT PAVEMENT JOINTING WILL NOT BE REQUIRED. IF JOINTED PAVEMENT IS DESIRED, JOINT SPACING SHOULD BE ADJUSTED SO THAT MOORING POINTS ARE A MINIMUM OF 0.6m [2'] FROM PAVEMENT JOINTS.

4. SEE FIGURE A12.6 FOR REINFORCING ADJACENT TO MOORING DEVICE.

5. TYPICAL PREFERRED SPACING BETWEEN MOORING DEVICES IS 6.1m [20']. SEE FIGURE A12.3 FOR ALLOWABLE MOORING AND STATIC GROUND POINT SPACING.

A12.2.4.3.2. Installation Option 2, Piers. This option allows the use of individual concrete piers for each mooring point as shown in Figure A12.8. The diameter and length of the pier must be based on the strength of the soil. This is presented in Table A12.1.

Figure A12.8. Army Mooring Point for Grassed Areas, Flexible Pavement ,or Rigid Pavement - Thickness Less Than 150 Millimeters (6 Inches).



NOTES

1. CORE DRILL ASPHALT PAVEMENT. FOR PIER LENGTH AND DIAMETER, SEE TABLE A12.1
2. SPIRAL REINFORCEMENT EQUIVALENT TO THE 13mm [#4] TIES MAY BE USED.
3. SEE FIGURE A12.3 FOR ALLOWABLE MOORING AND STATIC GROUND POINT SPACING

Table A12.1. Army Pier Length and Depths for Tiedowns.

Cohesive Soils				
Unconfined Compressive Strength [q_u in kg/m^2 [lb/ft^2]	Pier Diameter		Pier Length	
	Meters	Feet	Meters	Feet
q_u < 5,000 kg/m^2 [q_u < 1,000 lb/ft^2]	600 mm	2.0 ft	1,800 mm	6.0 ft
5,000< q_u <19,500 kg/m^2 [1,000< q_u <4,000 lb/ft^2]	500 mm	1.5 ft	1,800 mm	6.0 ft
q_u >18,500 kg/m^2 [q_u >4,000 lb/ft^2]	500 mm	1.5 ft	1,200 mm	4.0 ft

Cohesionless Soils				
Friction Angle ∅ in Degrees	Pier Diameter		Pier Length	
	Meters	Feet	Meters	Feet
∅ < 20°	600 mm	2.0 ft	2,100 mm	7.0 ft
20° ≤ ∅ ≤ 30°	600 mm	2.0 ft	1,800 mm	6.0 ft
∅ > 30°	500 mm	1.5 ft	1,800 mm	6.0 ft

A12.3. Existing Mooring Points for Army. Existing mooring points will be tested for structural integrity and strength as detailed in figure A12.2. If the existing mooring fails to meet the structural requirements listed herein, replacement of the mooring structure is required.. If the existing mooring point has an attached ground rod, its electrical resistance value must be measured. If it fails to meet resistivity requirements, a new static ground rod is required.

A12.3.1. Evaluation of Existing Mooring Points for Structural Adequacy:

A12.3.1.1. Adequate Mooring Points. Existing 19 millimeter [0.750 inch] diameter bimetallic copper covered steel rods, 1,800 millimeters [6 feet] long are considered adequate for immediate aircraft protection provided the following conditions are met:

A12.3.1.1.1. The existing rods are installed in rigid pavement.

A12.3.1.1.2. The existing rods do not show signs of deformation or corrosion.

A12.3.1.1.3. The existing rods are inspected for deformation and corrosion at least once a year and after each storm event with winds greater than 90 kilometers per hour [50 knots].

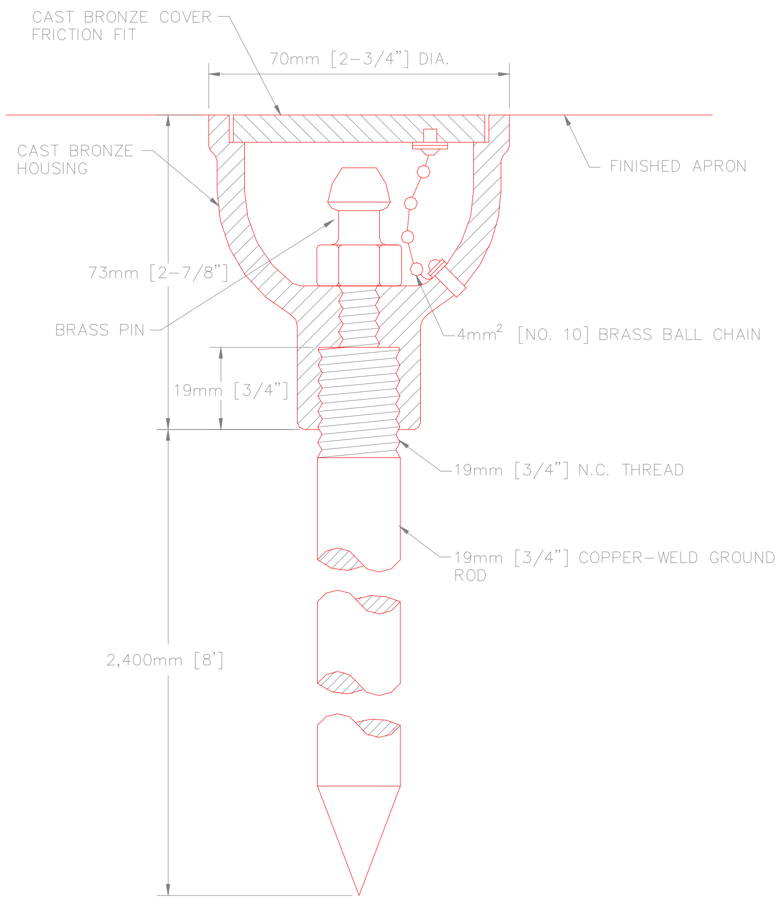
A12.3.1.2. Inadequate Mooring Points. At Army facilities, any existing rods that exhibit deformation or corrosion will be considered inadequate and require replacement. All existing 19 millimeter [0.750 inch] diameter, 1,800 millimeter [6 foot] long rods in flexible (asphalt) pavement, including those with a Portland cement concrete block at the surface, require replacement.

A12.3.2. Evaluation of Existing Mooring Points for Resistance. The maximum resistance measured, in accordance with IEEE Standard 142, Recommended Practice for Grounding of Industrial and *Commercial Power Systems*, of existing grounding points, will not exceed 10,000 ohms under normally dry conditions. If this resistance cannot be obtained, an alternative grounding system will be designed.

A12.4. Static Grounding Points for Army Fixed- and Rotary-Wing Facilities.

A12.4.1. Type. A static grounding point for Army facilities is a 3 meter [10 feet] rod with a closed eye (see Air Force Tiedown, figure A12.12) except when installed in a hangar. Inside hangars, the static ground point consists of a copperweld rod, attached to a bronze casting with a threaded connection, as shown in Figure A12.9.

Figure A12.9. Army Grounding Point Inside Aircraft Hangars.



A12.4.2. Layout:

A12.4.2.1. Fixed-Wing Layout. Static grounding points for fixed-wing aircraft will be located on the parking apron as recommended by the aircraft manufacturer or as required by the facility. Typically, one static grounding point is provided for every two parking spaces, and is located between the parking spaces.

A12.4.2.2. Rotary-Wing Layout. One static grounding point will be provided at each rotary-wing aircraft parking space, as shown in Figure A12.10.

A12.4.3. Installation. Static grounding points can be installed in new concrete or asphalt. New grounding points placed in turf areas will be constructed in an 12,000-square-millimeter [18-square-inch] concrete pad flush with existing ground. Static grounding points for turf areas are shown in Figure A12.11.

A12.4.4. Grounding Requirements. The maximum resistance measured, in accordance with IEEE Standard 142, of new grounding points will not exceed 10,000 ohms under normal dry conditions. If this resistance cannot be obtained, an alternative grounding system will be designed.

A12.5. Air Force Tiedowns:

A12.5.1. Type. For Air Force, tiedowns will be a 3 meter [10 foot] rod with a closed eye. The 3 meter [10 foot] rod will have a diameter of not less than 19 millimeters [0.75 inches], and the top will be bent with a closed eye (often referred to as a shepherd's crook bend), having an inside diameter of not less than 40 millimeters [1.5 inches] as shown in Figure A12.12. The rod will be copper, copper-clad steel, galvanized steel, or copper-zinc-silicone alloy. The Air Force tiedown is a mooring point and may be used as a static ground, but not an electrical ground.

Figure A12.10. Mooring and Ground Point Layout for Rotary-Wing Parking Spaces.

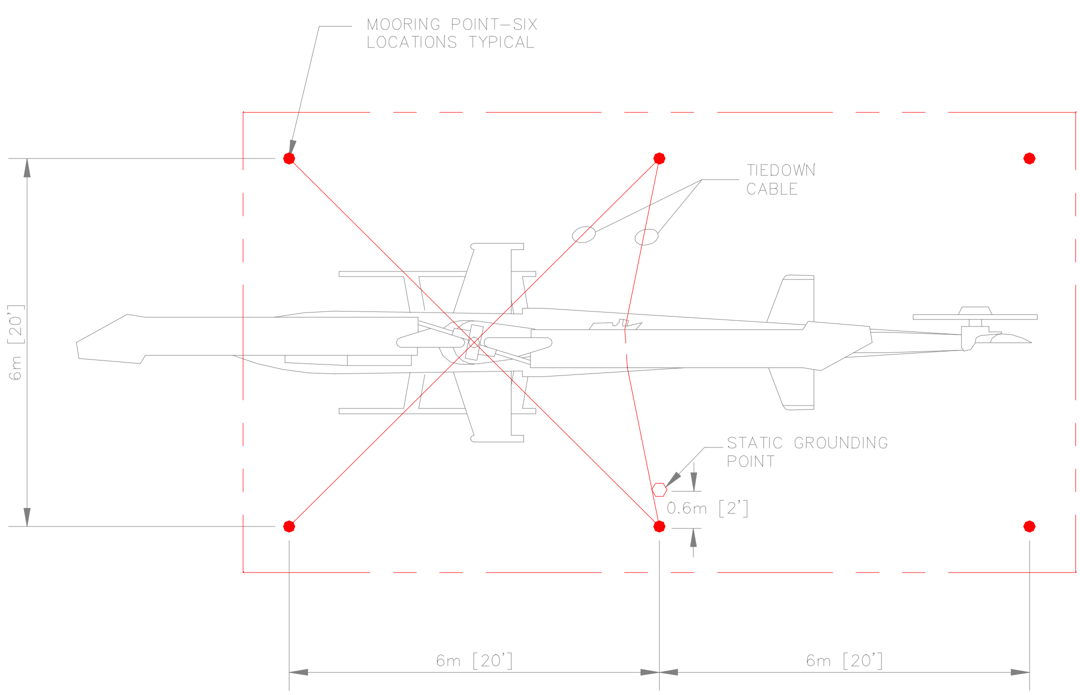
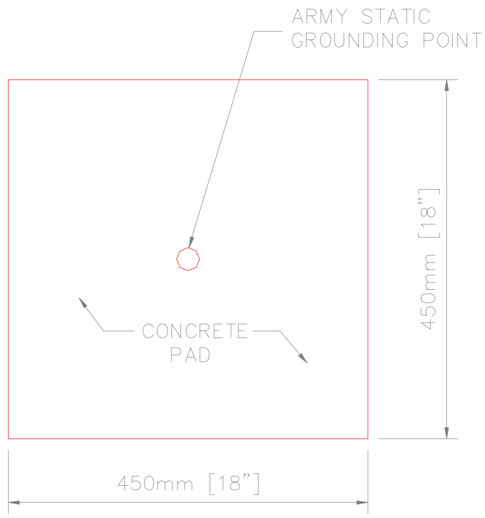


Figure A12.11. Army Grounding Point for Turf Areas.



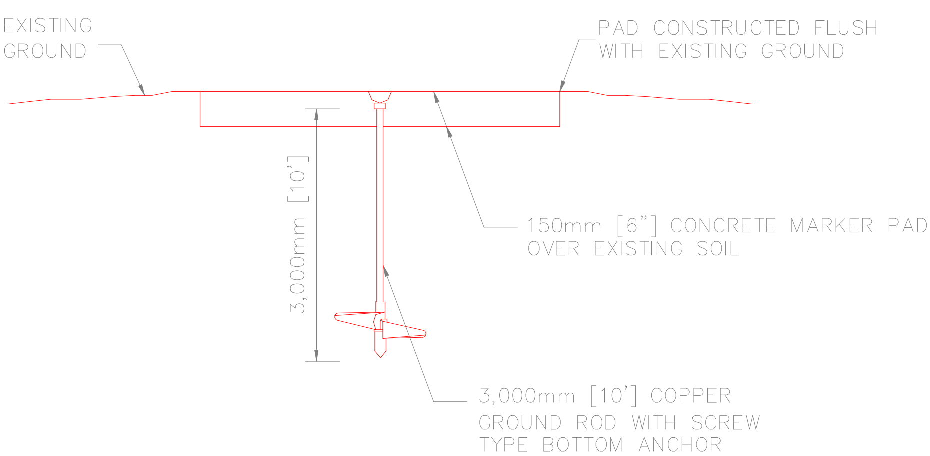
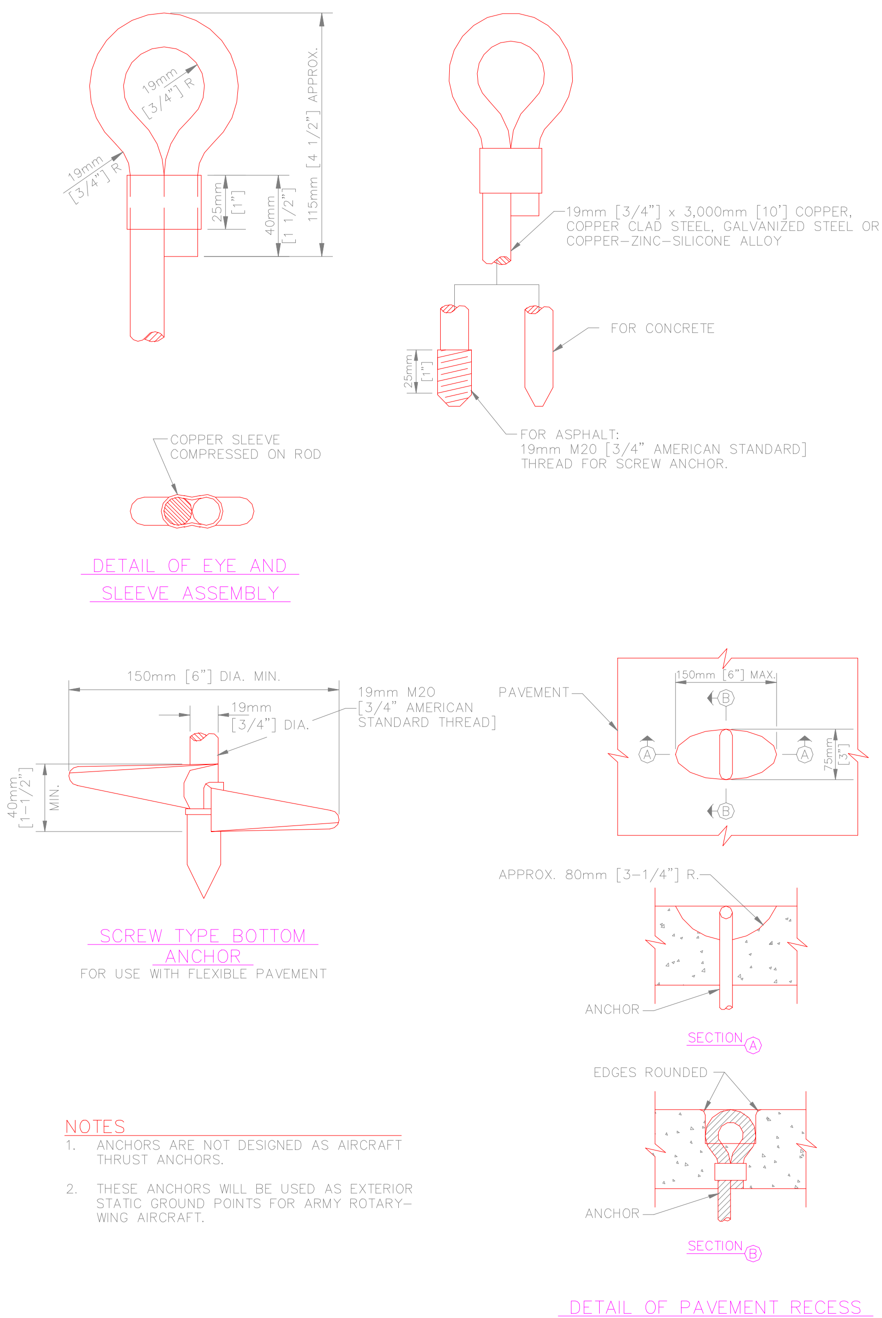
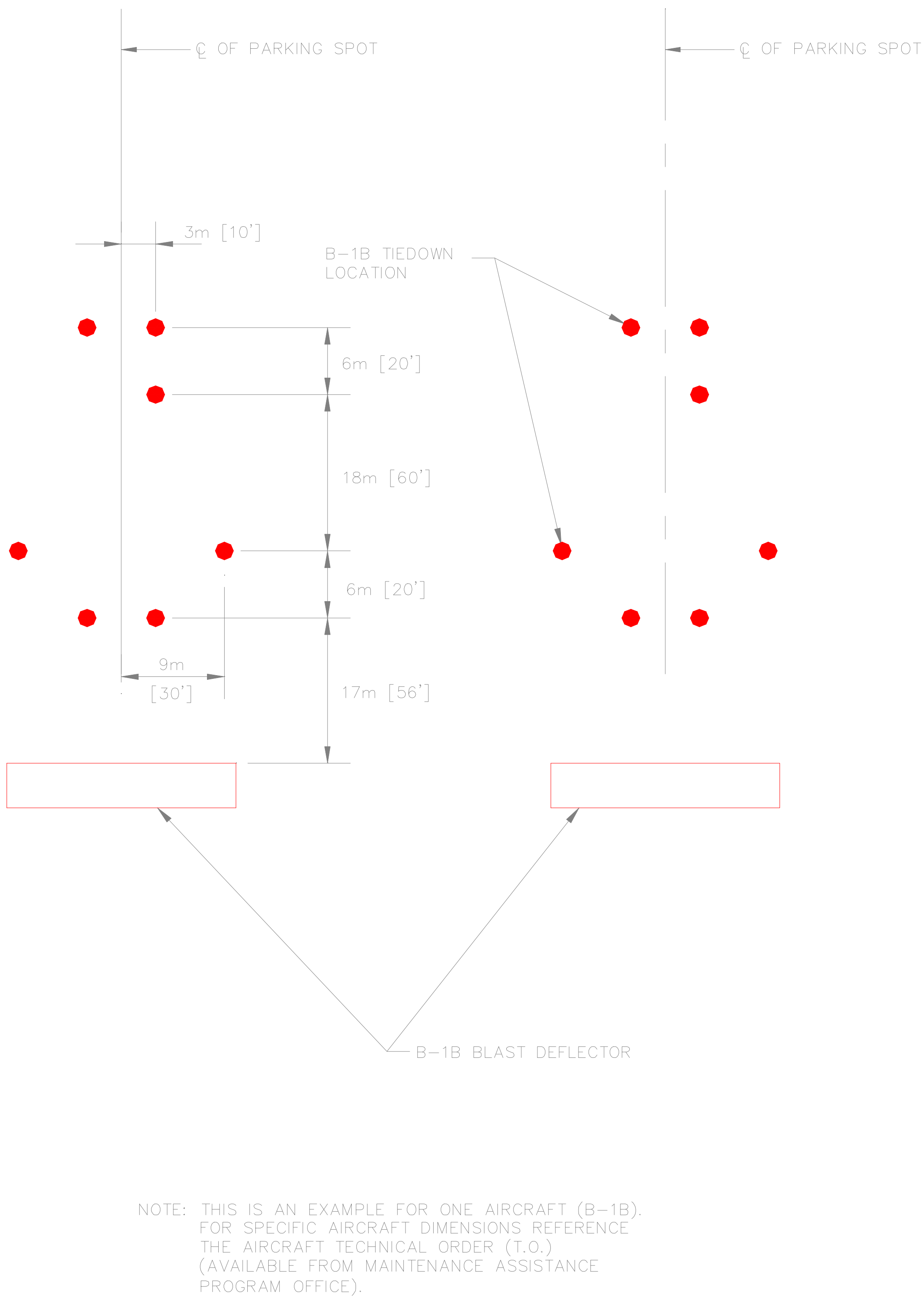


Figure A12.12. Air Force Tiedown and Static Ground.



A12.5.2. Layout. Tiedowns will be configured and spaced in accordance with the requirements of the mission aircraft and will vary from aircraft to aircraft. An example of a multiple fixed-wing aircraft tiedown layout is shown in Figure A12.13.

Figure A12.13. Example of Air Force Multiple Tiedown Layout for Fixed-Wing Aircraft.



A12.5.3. Installation:

A12.5.3.1. Rigid Pavement Tiedowns. Where the tiedowns are to be constructed in rigid pavement, the rods may be installed without bottom anchors. Tiedowns should be a minimum of 600 millimeters [2 feet] from any pavement edge or joint.

A12.5.3.2. Flexible Pavements Tiedowns. Where flexible pavement is to be constructed on frost susceptible soil, the rods will be equipped with a screw-type bottom end having a wing diameter of not less than 150 millimeters [6 inches] as shown in Figure A12.12 The rod will be threaded to permit attachment to the bottom anchor.

A12.5.3.3. Pavement Recess Design. The top of the tiedown will be set at pavement grade or not more than 6 millimeters [0.25 inches] below grade. A smooth rounded edge recess 75 millimeters [3 inches] wide and not more than 150 millimeters [6 inches] long will be provided in the pavement around the eye for accessibility and attachment of grounding cables. This is shown in Figure A12.12.

A12.5.4. Grounding Requirements. The maximum resistance of new tiedowns, measured in accordance with ANSI/IEEE Standard 142, should not exceed 10,000 ohms under normal dry conditions. If this resistance cannot be achieved, an alternative grounding system should be considered.

A12.6. Tiedown Mooring Eyes for Navy and Marine Corps. Requirements, layout, and installation details for Navy and Marine Corps tiedown mooring eyes are found in MIL-HDBK-1021/4, *Rigid Pavement Design for Airfields.* Requirements, layout, and installation details for Navy and Marine Corps grounding arrangements are found in MIL-HDBK 274, *Electrical Grounding for Aircraft Safety*.

Attachment 13

FLIGHTLINE VEHICLE PARKING - NAVY AND MARINE CORPS

A13.1. Contents. Flightline vehicle parking areas are provided for parking of mobile station-assigned and squadron-assigned vehicles and equipment. A fire and crash vehicle parking layout for Navy and Marine Corps facilities is included in NAVFAC P-80, *Facility Planning Factor Criteria for Navy and Marine Corps Shore Installations*. A parking layout for squadron equipment is found in MIL-HDBK-1028/1, *Aircraft Maintenance Facilities.*

A13.2. Army and Air Force Criteria. This attachment does not apply to the Army and Air Force.

A13.3. Location. Select parking areas that permit optimum efficiency in the use of equipment. Locations must conform to lateral safety clearance requirements for existing or planned airfield pavements. A typical site plan is shown in Figure A13.1. **NOTE:** No vehicle will be parked, nor a parking shed erected that would require an airfield safety waiver due to violation of required clearances.

A13.3.1. Area Required. Vehicle parking area requirements are shown in Table A13.1.

A13.3.2. Station-Assigned Vehicles. Provide parking areas adjacent to the aircraft fire and rescue station for fire and rescue vehicles. Where the fire and rescue station location does not permit immediate access to runways, a separate hardstand near the runway is required. Provide parking areas for other station-assigned vehicles adjacent to the parking apron.

A13.3.3. Squadron-Assigned Vehicles. Provide parking areas adjacent to hangar access for mobile electric power plants, oxygen trailers, utility jeeps, tow tractors, and other ground support equipment.

A13.3.4. Refueling Vehicles. Provide a central paved parking area for refueling trucks and trailers at least 30 meters [100 feet] from the nearest edge of the aircraft parking apron, as discussed in NAVFAC DM 22, *Petroleum Fuel Facilities*.

A13.4. Surfacing. Flightline parking areas will be paved with flexible or rigid pavement with selection based on minimum construction cost. Surfaces will be graded to drain and will have no irregularities greater than ± 3 millimeters [0.125 inch] in 3 meters [10 feet] of rigid pavement and ± 6 millimeters [0.25 inches] in 3 meters [10 feet] for flexible pavement. Design pavements for vehicle parking areas to support a 15,420 kilogram [34,000 pound] twin axle loading.

A13.5. Shelter. Where clearances permit, flightline vehicles may be housed in shelters as shown in Figure A13.2. When climatic conditions require it, walls and doors may be added. A method of heating emergency vehicle engines must be provided in those areas of extreme cold where engine starting is difficult. Structural material will vary in accordance with local climatic conditions.

A13.6. Lighting. Flood lighting will be provided for security and to facilitate operation of the equipment. Use low pressure sodium fixtures for energy conservation. Provide dusk to dawn lighting controls. Additional information on flood lighting is found in MIL-HDBK 1004/1, *Preliminary Design Considerations*.

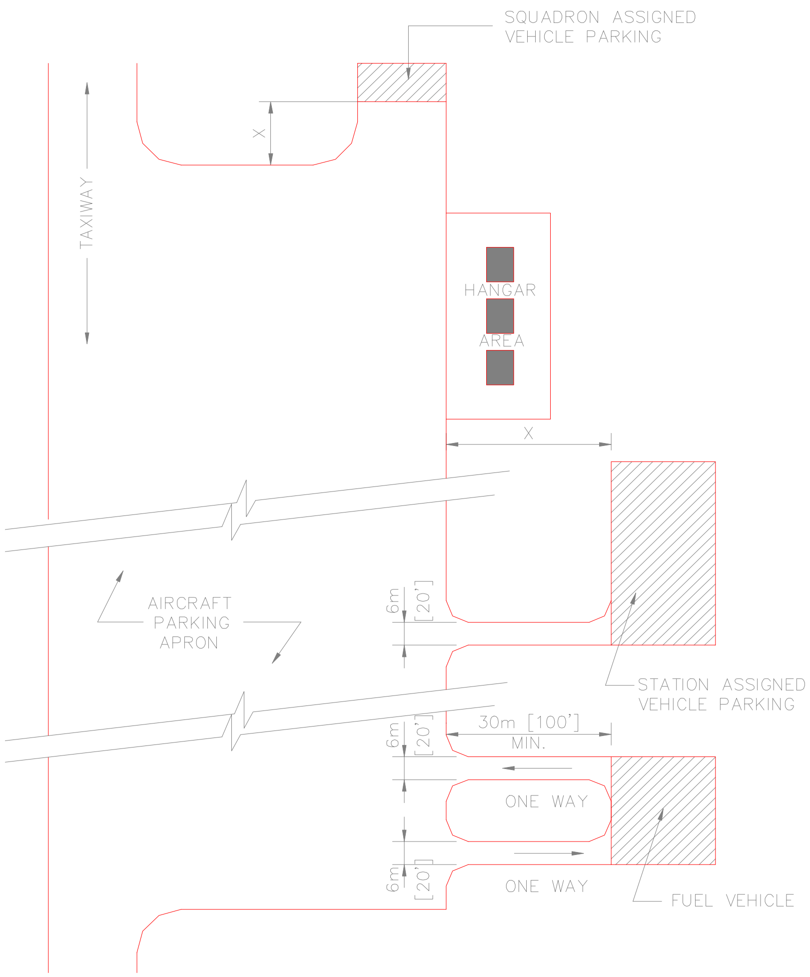
Table A13.1. Vehicle Parking Area Requirements.

Equipment (See note.)	**Square Meters**	**Square Yards**
Tow Tractor	16.7	20
Refueling Truck	39.3	47
Refueling Truck	58.5	70
Mobile Electric Power Plant	10.0	12
Oxygen Trailer	6.7	8
Utility Jeep	2.9	3.5
Bomb Truck	5.0	6
Bomb Trailer	3.3	4
Industrial Flat-Bed Truck	2.5	3
Industrial Platform Truck	2.5	3

Notes:
1. Parking area requirements for vehicles not shown will be dealt with on a case by case basis.
2. Metric units apply to new airfield construction, and where practical, modifications to existing airfields and heliports, as discussed in Paragraph 1.4.4.

.**Figure A13.1. Typical Sight Plan - Vehicle Parking.**

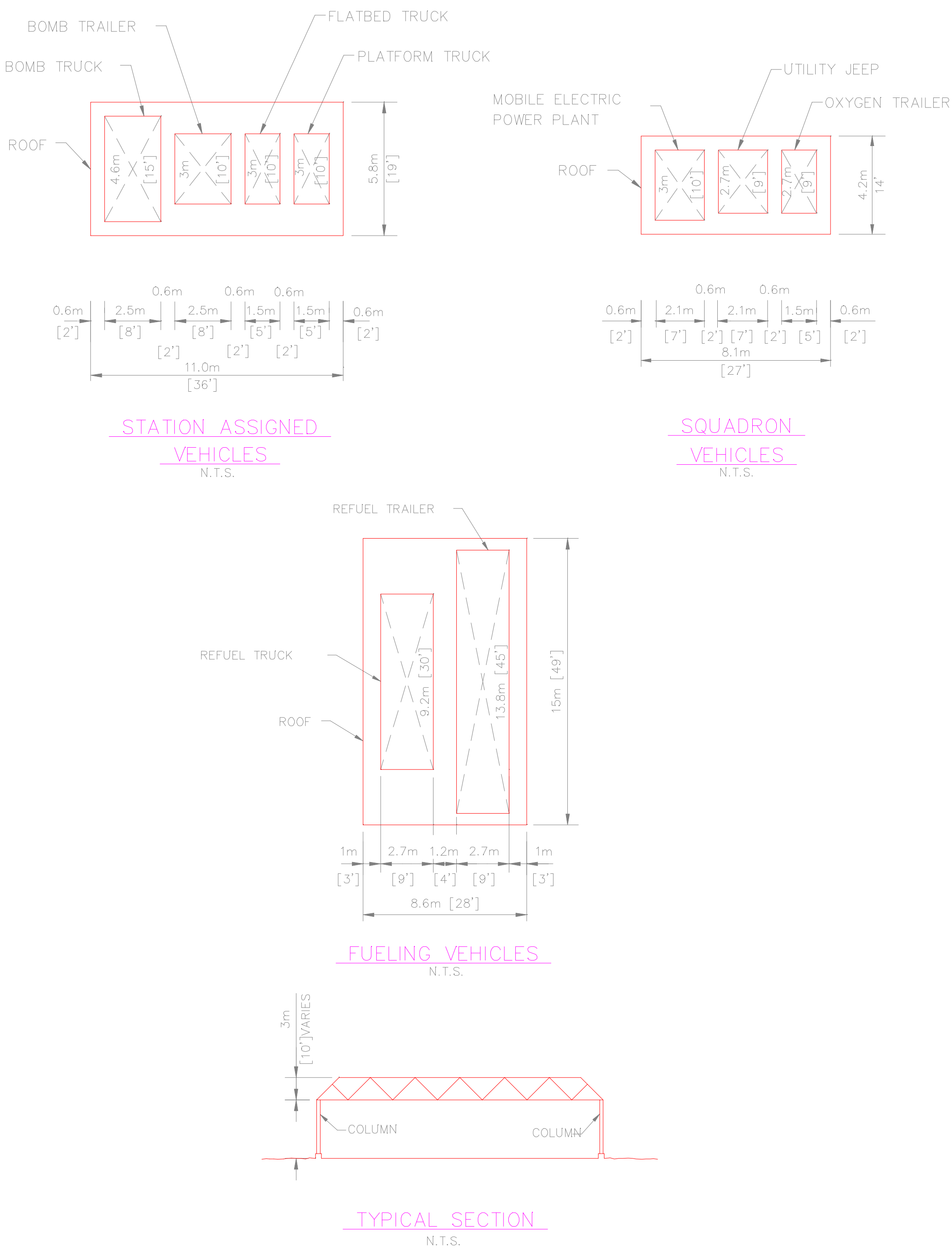
CLASS X	
A	23m [75']
B	30m [100']
ROTARY	23m [75']



SITE PLAN

N.T.S.

Figure A13.2. Typical Line Vehicle Shelters.



Attachment 14

DEVIATIONS FROM CRITERIA FOR AIR FORCE AIRFIELD SUPPORT FACILITIES

A14.1. Waiverable Airfield Support Facilities:

A14.1.1. Contents. This section provides information for selected airfield support facilities that are authorized to deviate from criteria presented in this manual with a specific waiver from the MAJCOM. This list is not all-inclusive.

A14.1.2. Army, Navy and Marine Corps Requirements. This attachment does not apply to the Army, Navy, and Marine Corps.

A14.1.3. Fixed Base Airport Surveillance Radar (ASR). Radar that displays range and azimuth typically is used in a terminal area as an aid to approach and departure control. Normally, ASR is used to identify and control air traffic within 60 nautical miles of the airfield. The ASR antenna scans through 360 degrees to give the air traffic controller information on the location of all aircraft within line-of-sight range. The antenna, located adjacent to the transmitter or receiver shelter, is elevated to obtain the required line-of-sight distance.

A14.1.4. Airport Rotating Beacon. Airport rotating beacons are devices that project beams of light, indicating the location of an air base. Detailed siting guidance is found in AFMAN 32-1076, *Visual Air Navigation Facilities*.

A14.1.5. Nondirectional Radio Beacon Facilities. Radio beacon facilities are nondirectional aids used to provide homing, fixing, and air navigation assistance to aircraft with suitable automated direction finding equipment. They consist of two categories: a medium power, low frequency beacon and a medium power, ultrahigh frequency beacon.

A14.1.6. Rotating Beam Ceilometer. The rotating beam ceilometer measures cloud height. It includes a projector, detector, and indicator. The projector and detector are sited in the runway approach 900 meters [3,000 feet] to 1,200 meters [4,000 feet] from the touchdown point. The detector is located closest to the runway threshold; the projector is located 120 meters [400 feet] from the detector. The indicator is installed in the weather observation building.

A14.2. Permissible Deviations from Design Criteria:

A14.2.1. Contents. This section furnishes siting information for airfield support facilities that may not conform to the airfield clearance and airspace surface criteria elsewhere in this manual. Siting must either conform to this guidance or a waiver from the MAJCOM is required. If the equipment renders satisfactory service at locations not requiring a clearance deviation, such locations should be selected to enhance the overall efficiency and safety of operations.

A14.2.2.. Visual Air Navigational Facilities. This term identifies, as a type of facility, all lights, signs and other devices located on, and in the vicinity of, an airfield that provide a visual reference to pilots for guidance when operating aircraft in the air and on the ground. These facilities supplement guidance provided by electronic aids, such as tactical air navigation (TACAN), and precision approach radar (PAR). For detailed siting criteria, see AFI 32-1044 and AFMAN 32-1076. Commonly used visual air navigational facilities are listed below:

A14.2.2.1. Approach lights

A14.2.2.2.. Runway lighting systems

A14.2.2.3. Taxiway lighting systems

A14.2.2.3. Runway distance markers

A14.2.2.4. Runway arresting system markers (locations of pendent cables).

A14.2.2.5. Taxiway signs (pilots' guidance, advisory and other informational signs on the airfield movement area)

A14.2.2.6. Visual Glide Slope Indicator (VGSI) Systems.

A14.2.3. Frangibility Requirement. All aboveground structures identified in this section, except as noted otherwise, must be constructed with breakable couplings or sections designed to support the desired load under specific local wind and ice conditions, but frangible enough to cause minimal damage to an aircraft if struck. Their shear resistance must be calculated with respect to local wind and ice load requirements, and other conditions of the installation. Two examples of such conditions are requirements for above grade aircraft arresting system components and mast-mounted electronic navigation or meteorological equipment whose performance would be adversely affected by movement caused by wind.

A14.2.4. Radar Facilities. These facilities provide air traffic controllers information on aircraft alignment, rate of descent, and relative position in the approach. These facilities include:

A14.2.4.1. Precision Approach Radar (PAR).

A14.2.4.2. Mobile Ground Control Approach (GCA) Facility.

A14.2.4.3. Mobile Radar Approach Control (RAPCON) Facility. See A14.1.3 for fixed airport surveillance radar (ASR) siting guidance.

A14.2.4.3.1. These units may be sited not less than 152.4 meters [500 feet] from the centerline of a runway to the near edge of the equipment. When it becomes necessary, place units between parallel runways that have insufficient distance to allow a 152.4 meters [500 feet] clearance to the centerline of the primary instrument runway and the lesser clearance to the centerline of the other runway. As a rule, these units are not sited between runways that have a separation of less than 304.8 meters [1,000 feet] between centerlines.

A14.2.4.3.2. While it is desirable, from a safety standpoint, to keep these units as low as possible, the final elevation will be determined by the appropriate support agency. The elevation is dependent on the necessary lines of site between the unit and calibration reflectors and the touchdown areas of the runways. If it is necessary to change the existing ground elevation to provide a proper height for these units, follow grading requirements discussed in Chapter 3.

A14.2.5. Emergency Generators, Maintenance and Personnel Facilities. These facilities may be collocated with GCA facilities and mobile RAPCON vans as follows:

A14.2.5.1. Trailers of standard mobile home construction or pre-engineered construction may be used for maintenance and personnel facilities.

A14.2.5.2. The entire GCA or RAPCON complex consisting of radar vans, emergency generators, maintenance and personnel trailers must be confined to a site not to exceed 45.7 meters long by 30.5 meters wide [150 feet by 100 feet], with the long side perpendicular to the main runway. The elevation of antennas and other projections will be held to the minimum essential for proper operation. Make every effort to keep the site as small as possible and to maintain the greatest possible distance from the runway. The perimeter of the site must be clearly marked and all future requirements contained within the area.

A14.2.6. Remote Microwave Link. This equipment provides remote operation and control of PAR and GCA facilities and must be sited adjacent to them. In siting the antenna, make sure that the increase in size of the total complex does not exceed the specified size of the area previously given for the GCA facility and RAPCON facility.

A14.2.7. Precision Approach Radar (PAR) Reflectors. Moving Target Indicator (MTI) reflectors, or "target simulators," may be sited not less than 45.7 meters [150 feet] from the near edge of a runway nor less than 38.1 meters [125 feet] from the near edge of a taxiway or apron to the centerline of the equipment. The height of these reflectors must be held to a minimum consistent with the operational requirements of the system. MTI reflectors sited less than 152.4 meters [500 feet] from the centerline of any runway must be of frangible construction, using breakaway sections in reflector masts. Tracking reference reflectors must not be installed closer than 152.4 meters [500 feet] to the centerline of any runway, nor exceed 18.3 meters [60 feet] in height above the centerline elevation of the nearest runway at the intersection of the equipment centerline perpendicular with the runway centerline.

A14.2.8. Airborne Radar Approach Reflectors. Airborne radar approach reflectors may be placed not less than 99.1 meters [325 feet] from the runway edge and not less than 121.9 meters [400 feet] nor more than 228.6 meters [750 feet] from the runway centerline to the edge of the equipment in a pattern parallel to the runway.

A14.2.9. Instrument Landing System (ILS):

A14.2.9.1. ILS Localizer Antennas. For best operational benefit, the system should be sited so that the antenna array is on the extended runway centerline, about 457.2 meters [1,500 feet] beyond the stop end runway threshold. As a rule, siting must conform to approach-departure clearance surface criteria discussed in Chapters 3 and 4. In some instances, local factors preclude siting the unit at 457.2 meters [1,500 feet] from the runway. When the siting constitutes an obstruction that cannot be waived, an offset from the extended runway centerline may be considered (see A14.2.9.1.2 below). To be acceptable, an offset site must conform to paragraphs A14.2.9.1.1 and A14.2.9.1.2 listed below:

A14.2.9.1.1. Angle of Divergence. Angle of divergence between the center of the localizer course and the extended runway centerline must not exceed 3 degrees.

A14.2.9.1.2. Offset. Intersection of the centerline and localizer and the extended runway centerline must occur at a point 335.3 meters [1,100 feet] to 365.8 meters [1,200 feet] toward the runway threshold from the Decision Height (DH) point on the glide slope. If the responsible facility engineering activity determines that an offset is feasible and the site is 152.4 meters [500 feet] or more from the runway centerline extended, the localizer may be installed without a waiver of clearance criteria. However, a waiver to operational criteria, TERPS, must be obtained as discussed in Attachment 2. These waivers will be processed at the request of the responsible MAJCOM office, as discussed in Attachment 2.

A14.2.9.1.3. Far Field Monitor (FFM). The FFM is considered part of the localizer system. However, it is sited at the opposite end of the runway. Typical locations are 365.8 meters [1,200 feet] to 914.4 meters [3,000 feet] prior to the landing threshold. FFM antenna height is determined by line of sight to the localizer antenna array. The line of sight requirement can be relaxed if satisfactory localizer signal reception is proven with a portable ILS receiver at the proposed lower height of the FFM site. Just as with the localizer antenna array, the FFM antenna shall not penetrate the approach-departure clearance surface criteria discussed in Chapters 3 and 4.

A14.2.9.2. ILS Glide Slope Antenna. The antenna mast or monitor should be located at a minimum distance of 121.9 meters [400 feet] from the runway centerline to the centerline of the antenna, and should not exceed 16.7 meters [55 feet] in height above the nearest runway centerline elevation. A mast height of over 16.7 meters [55 feet] is permitted if the minimum distance from the runway centerline is increased by 3.1 meters [10 feet] for each 305 millimeters [1 foot] the mast exceeds 16.7 meters [55 feet]. When the mast cannot, for technical or economic reasons, be located at a minimum distance of 121.9 meters [400 feet] from the runway centerline, the minimum distance may be reduced to not less than 76.2 meters [250 feet] from the centerline, provided the basic mast height of 16.7 meters [55 feet] is reduced 305 millimeters [1 foot] for each 1.7 meters [5 feet] it is moved toward the runway from the 121.9-meter [400-foot] point. Glide slope monitor units are considered part of the parent equipment. Emergency power generators must be as close to the facilities they support as practical.

A14.2.9.3. Marker Beacons. Marker beacons support instrument approach procedures. They are located on the runway centerline extended as noted.

A14.2.9.3.1. Outer Marker (OM) Beacon. The OM Beacon marks the point where the aircraft should intercept the glide slope. When the OM beacon cannot be located at this point, it is located between this point and the landing threshold, as close to this point as possible.

A14.2.9.3.2. Middle Marker (MM) Beacon. The MM beacon is located from 609.6 meters to 1,828.8 meters [2,000 to 6,000 feet] from the instrument runway threshold. It marks the point where the glide slope intersects the DH point of a Category (CAT) I ILS.

A14.2.9.3.3. Inner Marker (IM) Beacon. The IM Beacon is located to mark the point where the glide slope angle intersects the DH point of a CAT II ILS. An inner marker beacon is not used on a CAT I ILS. Marker beacons must not penetrate airspace clearance surfaces defined in this manual.

A14.2.10. Microwave Landing System (MLS). Criteria for siting an MLS will be added upon availability.

A14.2.11. Mobile Navigational Aids and Communication Facilities. These units follow the same general siting criteria as their fixed facility counterpart; and the same deviations from standard clearance criteria are permissible. Power generators for these facilities will be located as close to the equipment and in as small a site configuration as possible.

A14.2.12. Mobile Air Traffic Control Towers (MATCT). At least a 152.4 meters [500 feet] distance must be maintained between the centerline of any runway and the near edge of the tower. Power generators may be located in positions adjacent to the MATCT. Communication antennas to be used with these towers which are not mounted on the facility require the same separation from the runway centerline as the parent equipment, fixed or mobile.

A14.2.13. Terminal Very High Frequency Omnirange (TVOR) Facility and Very High Frequency Omnirange (VOR) Facility. TVOR and VOR facilities may be located not less than 152.4 meters [500 feet] from the centerline of any runway to the edge of the facility, nor less than 61 meters [200 feet] from the centerline of a taxiway.

A14.2.14. Tactical Air Navigation (TACAN) Facility and Very High Frequency Omnidirectional Radio Range (VORTAC) Facility. When used as terminal navigational aids, the TACAN and VORTAC facilities may be sited not less than 152.4 meters [500 feet] from the centerline of any runway to the edge of the facilities, provided the elevation of the antenna does not exceed 15.2 meters [50 feet] above the highest point of the adjacent runway centerline. For an on-base installation, the maximum angle of convergence between the runway centerline and TACAN end approach course is 30 degrees (30º) at a point 914.4 meters [3,000 feet] from the runway threshold.

A14.2.15. Runway Supervisory Unit (RSU). An RSU is a transportable or permanent all-weather, control tower type facility used to control or monitor aircraft movement. The RSU complex, consisting of the facility and all support equipment, must be confined to a site not to exceed 15.2 meters [50 feet] long by 15.2 meters [50 feet] wide. A minimum distance of 45.7 meters [150 feet] must be maintained between the near edge of the runway and the RSU facility and support equipment.

A14.2.16. Transmissometer Facilities. Transmissometer facilities measure and record horizontal visibility. They are installed adjacent to the ILS runway. Measurements are in terms of runway visual range (RVR), a reference of how far a pilot of an aircraft should be able to see high intensity runway edge lights. A transmissometer installation consists of a projector, detector, and recording or readout unit (RVR computer). **NOTE:** Transmissometer equipment that supports CAT I and CAT II operations may be sited not less than 121.9 meters [400 feet] from the centerline of the supported runway to the centerline of the equipment nor less than 61 meters [200 feet] from the centerline of any taxiway.

A14.2.17. Wind Measuring Set. The wind measuring set measures wind speed and direction. It consists of a transmitter, indicator and recorder. The transmitter is mounted on a mast and is sited where representative winds of the runway touchdown area can be measured. The recorder is installed in the weather observation building. The transmitter mast must be of frangible construction and may be sited not less than 152.4 meters [500 feet] from the runway centerline to the centerline of the equipment.

A14.2.18. Temperature-Humidity Measuring Set. The temperature-humidity measuring set measures temperature and a dew point of free air passing over a sensor. The set consists of a transmitter and indicator. The transmitter sensing elements are mounted on a pipe mast about 2 meters [6 feet] above the ground installed in a representative location on the airfield. The indicator is located in the weather observation building. The transmitter mast must be of frangible construction and may be sited not less than 152.4 meters [500 feet] from the runway centerline to the centerline of the equipment.

A14.2.19. Wind Direction Indicators:

A14.2.19.1. Wind Cones. Wind cone mountings are of three types. Type I is a hinged steel support; Type II is an anodized tapered aluminum hinged base support; and Type III is an "A" frame, fixed-base support with a pivoted center pipe support. All must be located at least 121.9 meters [400 feet] from the centerline of the runway to the centerline of the wind cone and in a location free from the effects of air disturbances caused by nearby objects. A height of more than 6.1 meters [20 feet] above ground elevation requires a waiver. Type I and Type II wind cone masts must be of frangible construction. For additional information on wind cones, see AFMAN 32-1076.

A14.2.19.2. Landing Direction Indicator (Landing "T" or Tetrahedron). A landing "T" or tetrahedron must be located at least 61 meters [200 feet] from the edge of a runway to the centerline of the equipment.

A14.2.20. General Information for Operational and Maintenance Support Facilities. Detailed siting information is furnished in this section, where appropriate. The list of facilities is divided into two categories: one related to aircraft operations; and one related to aircraft and facility maintenance. When the facility has dual use, it is grouped in the category of its predominant function.

A14.2.20.1. Operational Facilities:

A14.2.20.1.1. Aircraft Arresting Systems and Barriers (net engaging systems). A series of components used to engage an aircraft and absorb the forward momentum of a routine or emergency landing (or aborted take-off). See AFI 32-1043 for detailed siting criteria.

A14.2.20.1.2. Warmup or Holding Pad. The warmup or holding pad is a paved area adjacent to the taxiway and the runway end. It provides a means of bypassing aircraft being held at the runway end for various reasons. For detailed design and siting criteria, see Chapter 6.

A14.2.20.1.3. Arm/Disarm Pad. Arm/disarm pads are used for arming aircraft just before takeoff and for disarming weapons retained or not expended upon the aircraft's return. For detailed siting criteria and other information, see Chapter 6. When a personnel shelter is required, it is considered a part of the arm/disarm complex and must be sited according to explosives quantity-distance criteria as discussed in Attachment 10 and AFMAN 91-201.

A14.2.20.1.4. Helicopter Autorotation Lanes (also called "Slide Areas" or Skid Pads"). Such lanes may be sited on or between active runways without a waiver. Ensure they are sited to prevent conflicts in operations (Clear Zones must not overlap operational areas that will be used simultaneously).

A14.2.20.1.5. Vehicle Control Signs and Traffic Lights. These signs and lights provide drivers with guidance on traffic routes, service yard areas, and similar places. They provide warning information at runway and taxiway crossings and other hazardous points. Vehicle control signs and traffic lights may be located on the airfield movement area (including apron) without a waiver to criteria. In siting vehicle controls signs and traffic lights, make sure that they do not obstruct taxiing or towed aircraft.

A14.2.20.1.6. Runway Distance Markers. These markers are required for runways used by jet aircraft and are recommended for runways used by propeller type aircraft. For detailed siting guidance, see AFI 32-1044 and AFJMAN 32-1076.

A14.2.20.1.7. Aircraft Security System. If a security system or fence is approved by the Air Force for alert apron security, such as the microwave fence sensor or similar system as required by AFI 31-209, approval of the siting by the MAJCOM operation and safety offices will constitute a permanent waiver to airfield criteria. No fence shall penetrate the Primary or Approach-Departure Clearance Surfaces.

A14.2.20.2. Maintenance Facilities:

A14.2.20.2.1. Jet Blast Deflectors. Jet blast deflectors are installed where continual jet engine run-up interferes with the parking or taxiing of aircraft, the movement of vehicles, the activities of maintenance personnel, or where it causes the erosion of pavement shoulders. To provide maximum efficiency, jet blast deflectors must be positioned at their optimum distance from the aircraft. They should be located to maintain nominal aircraft taxiing clearance distance. When these clearances cannot be provided, safety procedures in AFI 11-218 for taxiing aircraft near obstacles must be followed.

A14.2.20.2.2. Floodlights. Floodlights illuminate aprons, alert stubs, specialized pads and other paved areas used for aircraft maintenance, loading/unloading, area security, and other reasons. Floodlights are exempt from apron clearance distance criteria. Ensure minimum aircraft wingtip clearance requirements are provided as discussed in Chapter 6. They are not, however, exempt from the vertical restriction imposed by the 7:1 transitional slope. Any deviation from this restriction must be waived, as discussed in Attachment 2.

A14.2.20.2.3. Fire Hydrants. Fire hydrants may be installed within the apron clearance distances discussed in Chapter 6, provided the height is no more than 610 millimeters [24 inches] above the ground. For additional siting criteria and other information on the location of fire hydrants, see MIL-HDBK-1008C.

A14.2.20.2.4. Explosives Safety Barricades. When barricades are an element in an aircraft alert complex, they are exempt from apron clearance distance criteria in Chapter 6. For information on explosives safety standards, see AFMAN 91-201.

A14.2.20.2.5. Ground Support Equipment (Mobile). Mobile ground support equipment is exempt from apron clearance distance criteria in Chapter 6. Examples of ground support equipment exempt under this category are: aerospace ground equipment, electrical carts, forklifts, towbar trailers, fire extinguisher carts, material handling equipment, flightline maintenance stands, and portable floodlights. Similar equipment may be included in this category. When such equipment is not in use, it must be removed from the aircraft parking area and stored in areas that do not violate lateral clearance requirements or other imaginary surfaces. For the purpose of this manual, equipment in use is defined as support equipment in place not more than three hours before aircraft arrival or three hours after aircraft departure.

A14.2.20.2.6. Flightline Vehicles. Flight line vehicles, such as pickup trucks and vans, are exempt from apron clearance criteria. When not required, these vehicles are relocated away from the vicinity of the parked aircraft.

A14.2.20.2.7. Ground Support Equipment (Stationary). Stationary ground support equipment and the associated safety and security components are exempt from apron clearance distance criteria in Chapter 6. Examples of exempt stationary ground support equipment are centralized aircraft support systems and pantograph refueling systems. This allowance also includes markers for petroleum, oils, and lubricants (POL) supply lines, communications and utility lines, and property demarkation. Ensure proper lighting and fire-safety features are included, and such equipment is located at least 230 meters (750 feet) from the runway centerline, and at least 50 meters (162 feet) from taxiway and taxilane centerlines.

A14.2.20.2.8. Crew Chief Shack. This facility, sometimes identified as an Airfield Maintenance Unit, is a trailer or permanent prefabricated structure that may be located at the end of the runway, close to the arm/disarm pad of the apron edge. It may also be located on an area of the apron where it will not be an obstacle to taxiing aircraft. Explosive quantity distance criteria in AFMAN 91-201 applies.

A14.2.20.2.9. Service Roads. Service roads may be located on the perimeter of alert aprons, around specialized aircraft parking pads, and similar apron areas, without adherence to the 38.1 meter [125-foot] apron clearance distance. In locating these roads, the wing overhang of the largest aircraft using the facility must be taken into account. The distance from the pad to the edge of the road is computed from the centerline of the aircraft's path, plus a 15.2 meter [50-foot] wingtip clearance.

A14.2.20.2.10. Fencing and Barricades (Jersey Barriers). Fencing and barricades are erected on airfields for a variety of purposes. Guidance for locating fences and barricades is the same as guidance for locating service roads as discussed in A14.2.20.2.9. No fence shall penetrate the Primary or Approach-Departure Clearance Surfaces, nor the graded area of the Clear Zone.

A14.2.20.2.11. Wildlife Control Devices. Various devices such as propane cannons, sirens, and traps may require siting within the airfield environment for wildlife control. Ensure these devices are sited at least 30.5 meters (100 feet) from the near edge of runways. When sited along taxiways and aprons, ensure these devices do not pose a hazard to taxiing or towed aircraft and as a minimum, conform to distance and height criteria for airfield signs (see AFMAN 32-1076).

A14.2.20.3. Miscellaneous:

A14.2.20.3.1. Telephone and Fire Alarm Systems. Telephone and fire alarm system boxes may be located on or in the vicinity of aprons without adherence to apron clearance criteria, providing the height of the structure does not constitute an obstruction to taxiing or towed aircraft.

A14.2.20.3.2. Trash Collection Containers. Dumpsters and similar equipment may be located in the vicinity of an apron without adherence to apron clearance criteria, providing the location does not constitute: an obstruction to taxiing or towed aircraft; or, a hazard to pedestrian or vehicular traffic from the debris. These containers must be placed to provide the minimum wingtip clearances provided in Chapter 6.

A14.2.20.3.3. Landscaping Around Flightline Facilities. All trees and shrubs should conform to the height restriction as discussed in A14.2.20.3.1 or must be located to provide the minimum wingtip clearances provided in Chapter 6.

A14.2.20.3.4. Other Apron Facilities. Facilities other than those previously mentioned within this section may require siting within the 38.1 meter (125 ft) apron clearance area due to their function and purpose. In these cases you must ensure wingtip clearance shown in Table 6.1 is provided. Some examples of these type facilities are hangars, washracks, taxi-through alert shelters, air passenger terminals, movable passenger access platforms (jetways), and weather shelters for sentries.

A14.2.20.3.5. Utility Access Points. Utility handholes and manholes should be constructed flush with grade but do not require waiver if the drop-off at the edge of the foundation is 76 millimeters (3 inches) or less.

Attachment 15

CONSTRUCTION PHASING PLAN

A15.1. Contents. A construction phasing plan should be included in the contract documents. The purpose of a phasing plan is to establish guidelines and constraints the contractor must follow during construction. It is recommended the construction phasing plan be submitted for coordination and review at the concept and design stage.

A15.2. Navy and Marine Corps Requirements. This attachment does not apply to the Navy and Marine Corps other than to provide applicable Navy publications where additional information may be found.

A15.3. Information to be Shown on the Construction Phasing Plan. The phasing plan should include, but is not necessarily limited to, the following:

A15.3.1. Phasing. All construction activities will be separated into phases. The phasing plan will show or describe the sequence of construction activity for each phase. The phasing plan will be incorporated into the contractor's management plan and reflected in the progress schedule. The work area limits, barricade, and temporary fencing requirements will be clearly delineated for each phase. The work area limits should include identification of restricted areas requiring escorts and free zones with secure areas.

A15.3.2. Aircraft Operational Areas. The phasing plan will identify active aircraft operational areas and closed pavement areas for each phase.

A15.3.3. Additional Requirements. If required, the location of flagmen, security guards, and other personnel should be shown. These locations should be supplemented in the specifications.

A15.3.4. Temporary Displaced Thresholds. Temporary displaced thresholds and temporary displaced threshold lighting requirements should be shown. These details will be presented in the drawings and supplemented in the specifications.

A15.3.5. Access. Construction vehicle access roads, including access gates and haul routes, will be shown.

A15.3.6. Temporary Marking and Lighting. Temporary pavement marking and lighting details will be presented on the phasing plan. Marking and lighting details are presented in AFI 32-1042 *Standards for Marking Airfields*, AFI 32-1044, *Visual Air Navigation Systems*, and TM 5-811-5, *Army Aviation Lighting*.

A15.4. Other Items to be Shown in the Contract Drawings. The following items are not necessarily a part of the phasing plan, but will be included in the contract documents.

A15.4.1. Storage. The contractor's equipment and material storage locations.

A15.4.2. Parking. The contractor's personnel vehicle parking area and access routes to the work area.

A15.4.3. Buildings. Location of the contractor's offices and plants.

A15.4.4. Disposal. Designated waste and disposal areas. Off-site disposal should be included in the specifications.

A15.5. Maximum Equipment Height. Included in the contract documents should be the maximum height of construction equipment expected to be in use during construction. This information, maximum height of construction equipment, must also be included on the Notice of Proposed Construction, which is to be submitted to the Federal Aviation Administration prior to the start of construction. If the maximum equipment height penetrates any airspace, it will be noted on the contract documents and Notice of Proposed Construction.

Attachment 16

MISCELLANEOUS FIGURES

The following figures are currently found in AFP 88-71/DG-1110-3-204, *Design Guide for Army and Air Force Airfields, Pavements, Railroads, Storm Drainage, and Earthwork,* and are provided here so they may be referenced.

Figure A16.1. Jet Blast Directed Away From Pavement on a Power Check Pad.

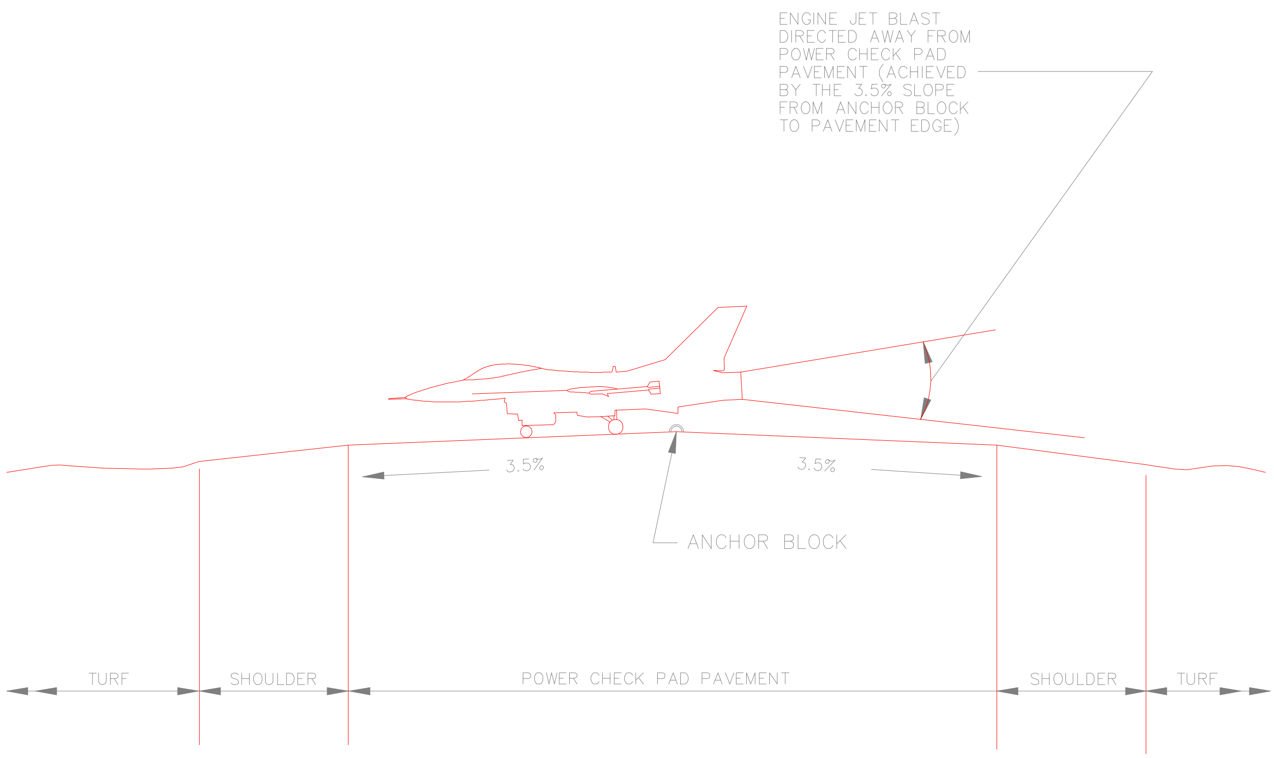


Figure A16.2. Example of Square Aircraft Anchor Block and Cross Section.

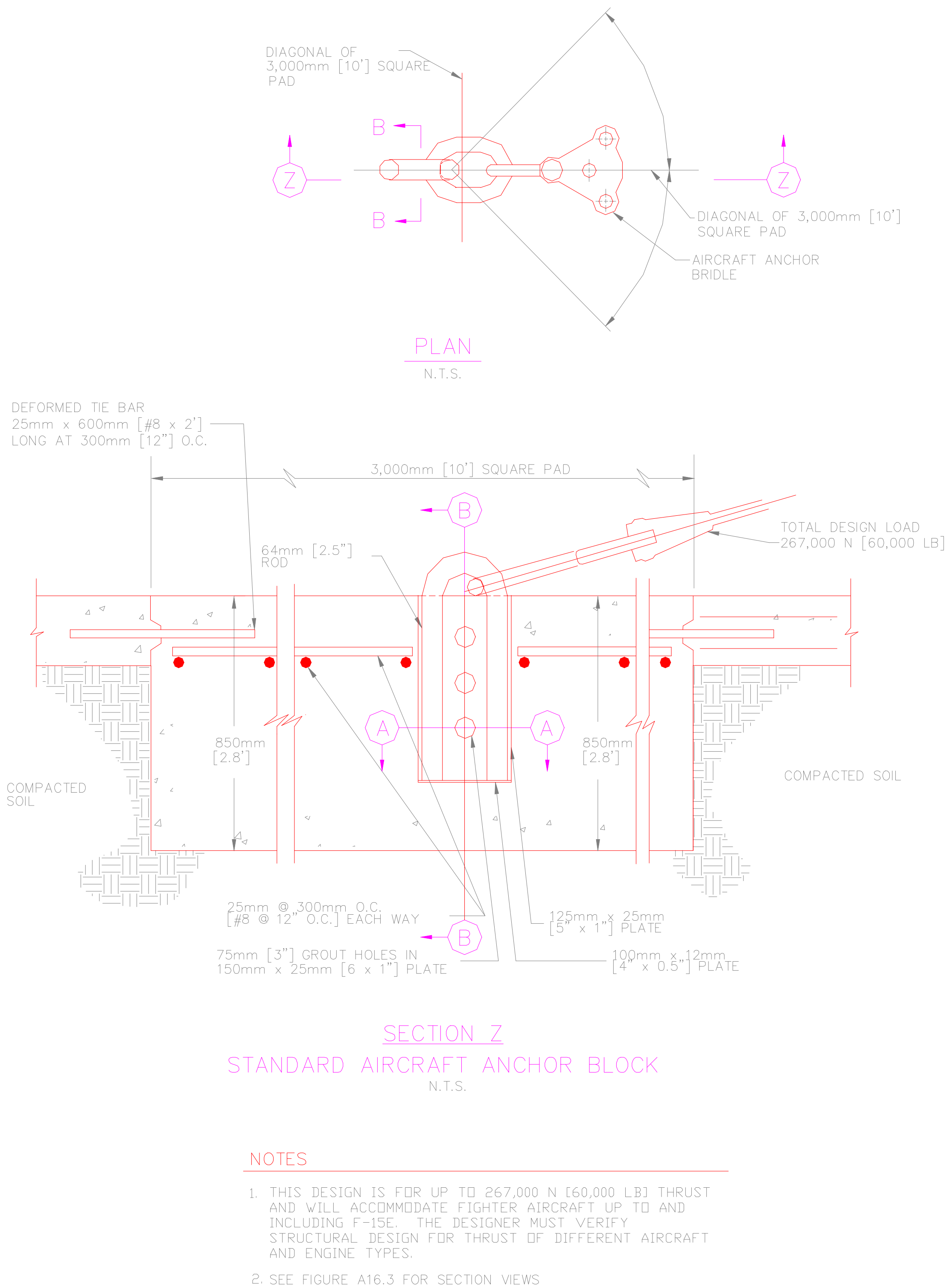


Figure A16.3. Example of Square Anchor Block, Cross Section A-A and B-B.

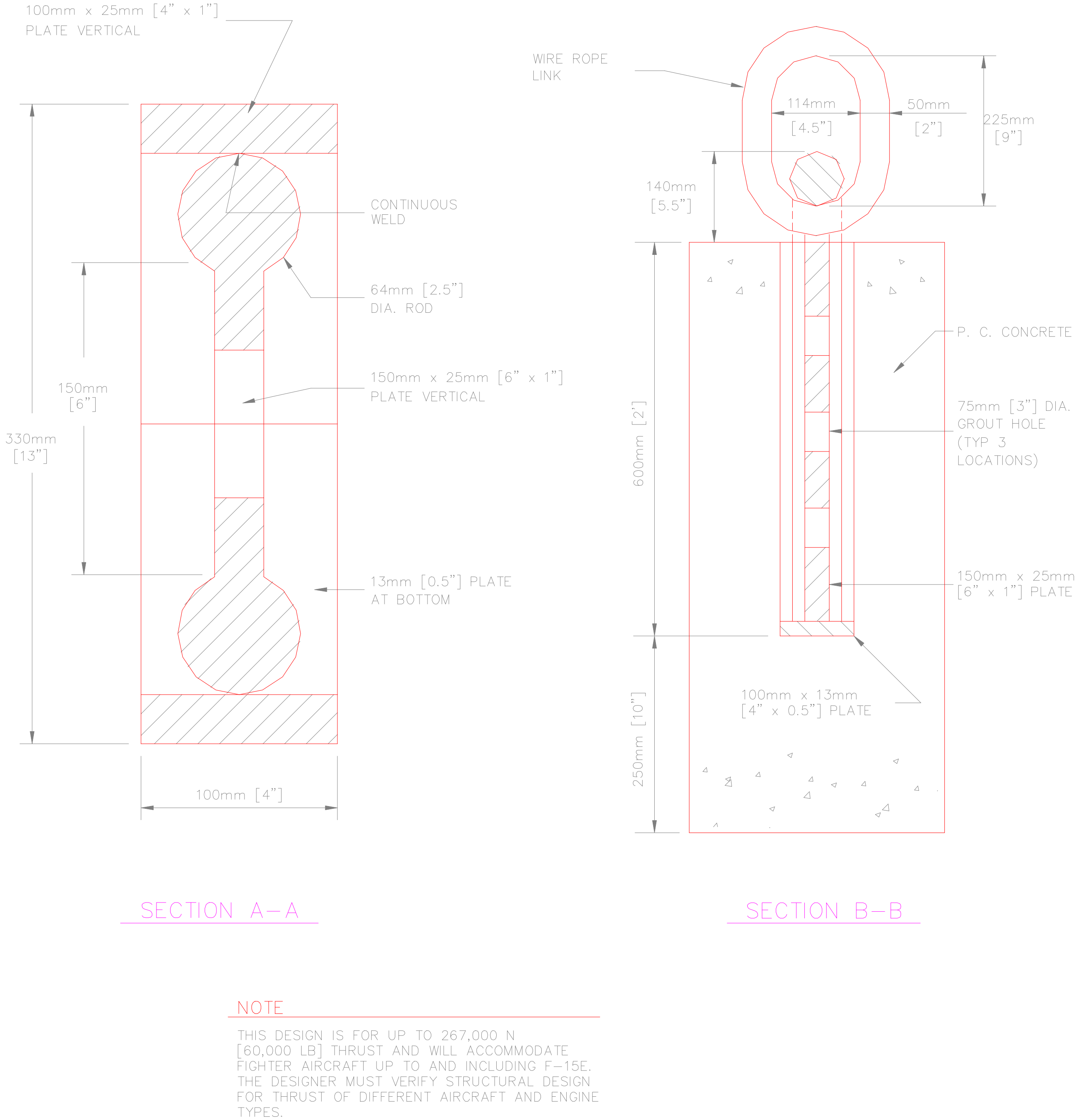
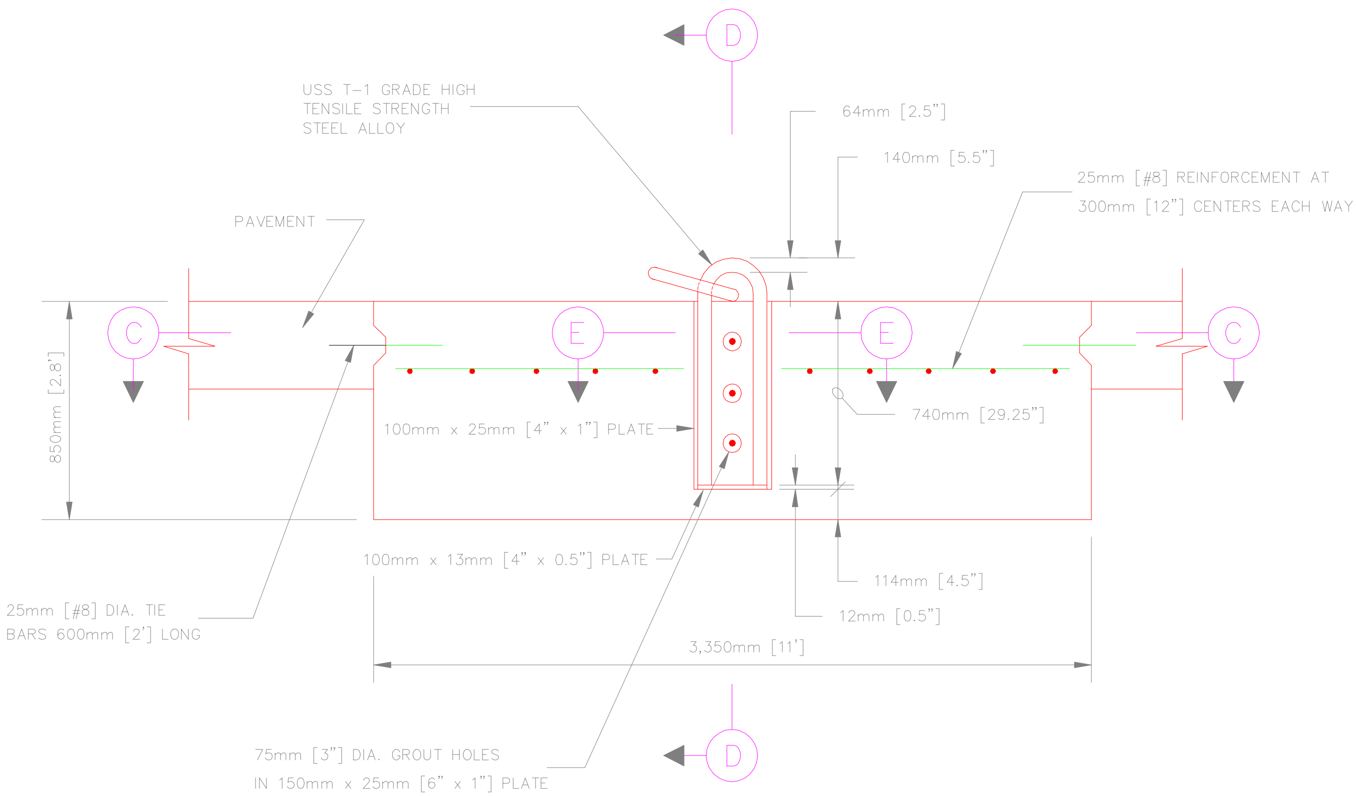


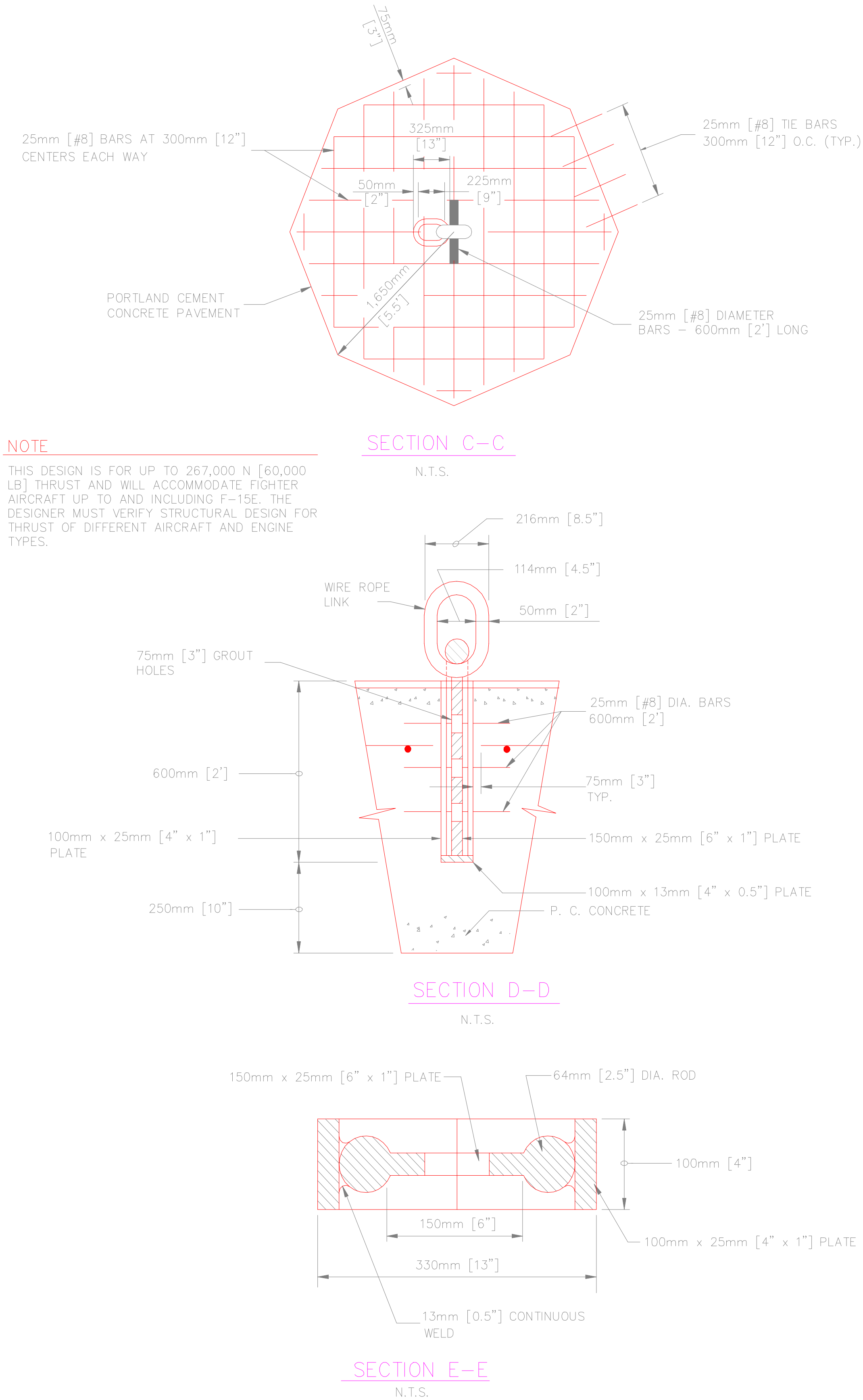
Figure A16.4. Example of Octagonal Anchor Block.



NOTE

1. THIS DESIGN IS FOR UP TO 267,000 N [60,000 LB] THRUST AND WILL ACCOMMODATE FIGHTER AIRCRAFT UP TO AND INCLUDING F-15E. THE DESIGNER MUST VERIFY STRUCTURAL DESIGN FOR THRUST OF DIFFERENT AIRCRAFT AND ENGINE TYPES.
2. SEE FIGURE A16.5. FOR SECTION VIEWS.

Figure A16.5. Example of Octagonal Anchor Block, Cross Sections C-C, D-D, and E-E.



Attachment 17

NAVIGATIONAL AIDS (NAVAIDS) DESIGN AND SUPPORT

The following table is provided to enable the airfield designer in finding the design manual and support agency for Navigational Aids.

Table A17.1. Navigational Aids (NAVAIDS) Design and Support.

Navigational Aid	Service	Comment	Design Manual and Siting Source	Support and Siting Agency	FAA Document
Precision Approach Radar (PAR)	Army		AR 95-2 TB 95-1 FM 11-486-23	Air Traffic Control Activity Attn: ATZQ-ATCA Ft. Rucker, AL	FAA Order 7031.2
	Air Force		Attachment 14	Contact MAJCOM ATCALS	
	Navy and Marine Corps		MIL-HDBK-1024/1		
Airport Surveillance Radar (ASR)	Army		AR 95-2 TB 95-1 FM 11-486-23	Air Traffic Control Activity Attn: ATZQ-ATCA Ft. Rucker, AL	FAA Order 6310.13 AC 150/5300-13
	Air Force		Attachment 14	Contact MAJCOM ATCALS	
	Navy and Marine Corps		MIL-HDBK-1024/1		
VOR (Very High Frequency Omni-Directional Range)	Army		AR 95-2 TB 95-1 FM 11-486-23	Air Traffic Control Activity Attn: ATZQ-ATCA Ft. Rucker, AL	FAA Order 6820.10 AC 150/5300-13
	Air Force		Attachment 14	Contact MAJCOM ATCALS	
	Navy and Marine Corps		MIL-HDBK-1024/1		

TVOR (Terminal VOR)	Army		AR 95-2 TB 95-1 FM 11-486-23	Air Traffic Control Activity Attn: ATZQ-ATCA Ft. Rucker, AL	FAA Order 6820.10 AC 150/5300-13
	Air Force		Attachment 14	Contact MAJCOM ATCALS	
	Navy and Marine Corps		MIL-HDBK-1024/1		
TACAN (Tactical Air Navigation)	Army		AR 95-2 TB 95-1 FM 11-486-23	Air Traffic Control Activity Attn: ATZQ-ATCA Ft. Rucker, AL	FAA Order 6820.10
	Air Force		Attachment 14	Contact MAJCOM ATCALS	
	Navy and Marine Corps		MIL-HDBK 1024/1		
VORTAC (VOR and TACAN)	Army		AR 95-2 TB 95-1 FM 11-486-23	Air Traffic Control Activity Attn: ATZQ-ATCA Ft. Rucker, AL	FAA Order 6820.10
	Air Force			Contact MAJCOM ATCALS	
	Navy and Marine Corps		MIL-HDBK 1024/1		
Check Signs	Army	Ground Receiver Check-Points	TM 5-823-4	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	
	Air Force	Ground Receiver Check-Points	ETL 94-01		
	Navy and Marine Corps		MIL-HDBK 1024/1		

NDB (Non-Directional Beacon)	Army		TM 5-811-5 AR 95-2 TB 95-1 FM 11-486-23	Air Traffic Control Activity Attn: ATZQ-ATCA Ft. Rucker, AL	AC 150/5300-13
	Air Force	Use FAA Siting Criteria		Contact MAJCOM ATCALS	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
LORAN-C	Army	Not Applicable			
	Air Force	Use FAA Criteria		Contact MAJCOM ATCALS	
	Navy and Marine Corps		MIL-HDBK-1024/1		
Transmis-someter	Army		Attachment 14		FAA AC 97-1A
	Air Force		Attachment 14		
	Navy and Marine Corps	Not Applicable			
Wind Measuring Equipment	Army		Attachment 14		
	Air Force		Attachment 14		
	Navy and Marine Corps		Attachment 14		
Temperature-Humidity Measuring Equipment	Army		Attachment 14		
	Air Force		Attachment 14		
	Navy and Marine Corps		Attachment 14		

Wind Cones (also referred to as Wind Sock)	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 150/5340-21 AC 150/5340-23 AC 150/5345-27
	Air Force		Attachment 14 and AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
Landing Direction Indicator (Landing "T" or Tetrahedron)	Army	Not Applicable			AC 150/5340-21
	Air Force		Attachment 14	Contact MAJCOM ATCALS	
	Navy and Marine Corps	Not Applicable			
Rotating Beam Ceilometer	Army				
	Air Force		Attachment 14		
	Navy and Marine Corps				
Instrument Landing System (ILS) (Including: Localizer, Glide Slope & Outer Marker)	Army		AR 95-2 TB 95-1 FM 11-486-23	Air Traffic Control Activity Attn: ATZQ-ATCA Ft. Rucker, AL	FAA Order 6750.16 AC 150/5300-13
	Air Force		Attachment 14	Contact HQ AFFSA/XOIP	
	Navy and Marine Corps		MIL-HDBK 1024/1 NAVAIR 51-50AAA 2	NAVAIRSYSCOM 8.0Y	

Global Positioning System (GPS) Local Area Augmentation System (LAAS)	Army		AR 95-2 TB 95-1 FM 11-486-23	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	FAA Order 8260.38
	Air Force	Use FAA Criteria		Contact MAJCOM ATCALS	
	Navy and Marine Corps	Use FAA Criteria			
VASI (Visual Approach Slope Indicator)	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	FAA Order 6850.2 AC 150/5340-14
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
PAPI (Precision Approach Path Indicator System)	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	FAA Order 6850.2 FAA Order 6850.28 AC 150/5345-28
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA2	NAVAIRSYSCOM 80.Y	
Optical Landing System	Army	Not Applicable			
	Air Force	Not Applicable			
	Navy and Marine Corps		NAVAIR 51-50AAA 2	NAVAIRSYSCOM 8.0Y	

Wheel-Up, Wave off Lighting	Army	Not Applicable			
	Air Force	Not Applicable			
	Navy and Marine Corps		NAVAIR 51-50AAA 2 NAVFAC P-272	NAVAIRSYSCOM 8.0Y	
Runway End Identifier Light (REILs)	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	FAA Order 6850.2 FAA Order 6850.24 AC 150/5300-13 AC 150/5340-14
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA 2 NAVFAC P-272	NAVAIRSYSCOM 8.0Y	
Lead-in Lighting System (LDIN)	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	FAA Order 6850.2 AC 150/5300-13
	Air Force	Not Applicable			
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
MALS (Medium Intensity Approach Lighting Systems)	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	FAA Order 6850.2 AC 150/5340-14
	Air Force	Not Applicable			
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	

MALSF (Medium Intensity Approach Lighting System with Sequenced Flashers)	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	FAA Order 6850.2 AC 150/5340-14
	Air Force	Not Applicable			
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
MALSR (Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (RAIL)	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	FAA Order 6850.2 FAA Order 6850.8 FAA Order 6850.11
	Air Force	Not Applicable			
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
ALSF-1 (High Intensity Approach Lighting System with Sequenced Flashers in CAT I Configuration)	Army	Use Air Force Critertia			
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA 2 MIL-HDBK-1023/1	NAVAIRSYSCOM 8.0Y	
ALSF-2 (High Intensity Approach Lighting System with Sequenced Flashers in CAT II Configuration)	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	FAA Order 6850.2
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA 2 MIL-HDBK-1023/1	NAVAIRSYSCOM 8.0Y	

SALS (High Intensity Short Approach Lighting System)	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
SALSF (High Intensity Short Approach Lighting System with Sequenced Flashers)	Army	Use Air Force Criteria			FAA Order 6850.2
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
SSALR (Simplified Short Approach Lighting System with Runway Alignment Indicator Lights)	Army	Use Air Force Criteria			FAA Order 6850.2
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
ODALS (Omni-directional Approach Light System)	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	FAA Order 6850.2 FAA Order 6850.21 AC 150/5300-13
	Air Force	Not Applicable		HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2 REILS only	NAVAIRSYSCOM 8.0Y	

Carrier Deck Lighting, Simulated	Army	Not Applicable			
	Air Force	Not Applicable			
	Navy and Marine Corps		NAVAIR 51-50AAA-2 MIL-HDBK-1023/1	NAVAIRSYSCOM 8.0Y	
Helicopter Perimeter Lighting System	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 150/5390-2
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
Helicopter Landing Direction Lighting System	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 150/5390-2
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
Approach Direction Lighting System	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 150/5390-2
	Air Force		AFI 32-1044	HQ AFCESACESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	

Helipad Insert Lights	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 150/5390-2
	Air Force	Not Applicable			
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
Helipad Floodlights	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 150/5390-2
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
Helipad VMC (Visual Meteor-ological Conditions)	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 150/5390-2
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
Helipad IMC (Instrument Meteor-ological Conditions)	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 150/5390-2
	Air Force	Not Applicable			
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	

Rotating Beacon and Identification Beacon	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 150/5300-13 AC 150/5340-21 AC 150/5345-12
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
Airport Surface Detection Equipment (ASDE)	Army	Not Applicable			AC 150/5220-13
	Air Force	Use FAA Criteria			
	Navy and Marine Corps	Not Applicable			
AWOS/ASOS (Automatic Weather Observation Station)	Army	Not Applicable			FAA Order 6560.20 AC 150/5220-16 AC 150/5300-13
	Air Force	Use FAA Criteria			
	Navy and Marine Corps	Not Applicable			
In-Pavement Ice Sensor	Army	Not Applicable			AC 150/5220-13
	Air Force	Use FAA Criteria			
	Navy and Marine Corps	Not Applicable			
High Intensity Runway Edge Lights (HIRL)	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 150/5340-24 AC 150/5345-46
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	

Medium Intensity Runway Edge Lights (MIRL)	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 150/5340-24 AC 150/5345-46
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
Circling Guidance Lights	Army	Not Applicable			
	Air Force	Not Applicable			
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
Threshold Lights	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 150/5340-24 AC 150/5345-46
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
Runway End Lights	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 150/5340-24 AC 150/5345-46
	Air Force		AFI 32-1044	HQ AFCESA 850-283-6352	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	

Displaced Threshold Lights	Army	Use Air Force Criteria	Not Addressed	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 150/5340-24 AC 150/5345-46
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 50-51AAA 2	NAVAIRSYSCOM 8.0Y	
Runway Distance Markers	Army	Use Air Force Criteria		U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 150/5340-18
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
Arresting Gear Markers	Army	Use Air Force Criteria			
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
Runway Centerline Lights	Army	Use Air Force Criteria		U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 150/5340-4
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	

Touchdown Zone Lights	Army	Use Air Force Criteria		U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 150/5340-4
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
Taxiway Edge Lights	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 150/5340-24 AC 150/5345-46
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
Hoverlane Centerline Lights	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	
Taxiway Centerline Lights	Army	Use Air Force Criteria		U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 150/5340-19
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
Runway Exit Lights	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 150/5340-24
	Air Force		AFI 32-1044	HQ AFCESA 850-283-6352	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	

Taxiway Hold Lights	Army	Use Air Force Criteria		U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
Taxiway Guidance Signs	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 150/5340-18 AC 150/5345-44
	Air Force		AFMAN 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
Obstruction Lighting	Army		TM 5-811-5 - see FAA documents	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	AC 70/7460-1 AC 150/5340-21 AC 150/5345-43
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2 Use FAA	NAVAIRSYSCOM 8.0Y	
Air Traffic Control Tower Siting Criteria	Army			Air Traffic Control Activity Attn: ATZQ-ATCA Ft. Rucker, AL	FAA Order 6480.4 AC 150/5300-13
	Air Force		Attachment 18	Contact HQ AFFSA/XR Andrews AFB MD	
	Navy and Marine Corps		MIL HDBK 1024/1		

Lighting Equipment Vault	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	
	Air Force		AFI 32-1044	HQ AFCESA/CESE	
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
Fixed Area Lighting	Army		TM 5-811-5	U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	IES-RP-14-1987
	Air Force	Not Applicable			
	Navy and Marine Corps		NAVAIR 51-50AAA-2	NAVAIRSYSCOM 8.0Y	
Mobile Navigational Aids and Communication Facilities	Army			Air Traffic Control Activity Attn: ATZQ-ATCA Ft. Rucker, AL	
	Air Force		Attachment 14 of this Manual, and AFI 32-1044	HQ AFCESA/CES	
	Navy and Marine Corps	Not Applicable			
Mobile Air Traffic Control Towers (MATCT)	Army			Air Traffic Control Activity Attn: ATZQ-ATCA Ft. Rucker, AL	
	Air Force		Attachment 14		
	Navy and Marine Corps	Not Applicable			

Runway Supervisory Unit (RSU)	Army		Not Addressed	Air Traffic Control Activity Attn: ATZQ-ATCA Ft. Rucker, AL	
	Air Force		Attachment 14		
	Navy and Marine Corps	Not Applicable			
Vehicle Control Signs and Traffic Lights	Army	Contact Support Agency		U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	
	Air Force		Attachment 14		
	Navy and Marine Corps		P-80.3		
Vehicle Directional Signs	Army	Contact Support Agency		U.S. Army Corps of Engineers Attn: CEMP-ET Washington, D.C.	
	Air Force		Attachment 14		
	Navy and Marine Corps		P-80.3		

Attachment 18

AIR TRAFFIC CONTROL TOWER (ATCT) SITING CRITERIA

A18.1. General Information. Locating and siting an ATCT is a complex procedure that involves many operational and technical requirements. The tower cab must be correctly oriented. The area to be controlled must be visible from the cab. The air traffic controller must have proper depth perception of the area under surveillance, and there can be no electronic interference with equipment in the cab nor with navigational equipment on the ground. For these considerations and other operational and technical aspects of selecting a site, consult Air Force Flight Standards Agency, Engineering and Systems Integration Branch (HQ AFFSA/XRE), 1535 Command Drive, Suite D309, Andrews AFB, MD 20762-7002 and 38 Engineering Installation Wing (38 EIG/EICG), 3580 D AVE, Bldg 201W, Tinker AFB, OK 73145-9155, in the early stages of planning. A site survey will be conducted to determine the best siting for the proposed ATCT. For accurate planning and design considerations, the site survey should be conducted within five years of the projected ATCT construction completion date. More specific architectural, structural, mechanical, and electrical systems design requirements may be found in the Air Traffic Control Tower Design Guide published by the Design Group Division at Headquarters, Air Force Center for Environmental Excellence (HQ AFCEE/DCD), 8004 Arnold Drive, Brooks AFB TX 78235-5361.

A18.2. Siting Criteria. ATCT siting and height determination require sound engineering principles and close coordination with the host base. Siting project engineers should consider factors that relate to the economics of each candidate site, such as accessibility to utilities, subsoil and ground water conditions, expansion possibilities, as well as selecting a site requiring a tower of the minimum height necessary to meet the specific requirements. The following specific guidelines should be followed:

A18.2.1. The air traffic controllers operating this facility should have a clear, unobstructed, and direct view to all operating positions of the airport traffic area; to the approach end of the primary instrument runway; and all other active runways, taxiways, parking aprons, test pads, and similar areas. The tower should be located close to runway midpoints and equidistant from other airfield areas to the greatest extent possible.

A18.2.2. The site must provide sufficient area to accommodate the initial building and any planned expansions, including vehicle parking, fuel storage tanks, and exterior transformers.

A18.2.3. Siting of the ATCT must meet explosives separation distance criteria in AFMAN 91-201.

A18.2.4. As a minimum, the site must conform to ground system and obstruction clearance criteria for Category II Instrument Landing Operations (see Federal Aviation Administration Handbook (FAAH) 7110.65, Air Traffic Control, and AFMAN 11-230).

A18.2.5. The ATCT must be sited where it will not detract from the performance of existing or planned electronic air navigational facilities (terminal very high frequency omnirange (TVOR), air-port surveillance radar (ASR), and tactical air navigation (TACAN)). There are no criteria that establish minimum distances from electronic air navigational facilities. However, the facilities most likely to be affected are the TVOR, TACAN, and ASR. The ATCT should be no closer than 300 m (1,000 feet) from these three facilities. Other electronic air navigation facilities (precision approach radar, ILS) are not as likely to be affected because their usage is more directed along the runway's major axis. However, care should be taken in siting the ATCT so it does not conflict with proper operation of these facilities.

A18.2.6. Sufficient depth perception of all surface areas to be controlled must be provided. This is the ability to differentiate the number and type of grouped aircraft and ground vehicles and to observe their movement and position relative to the airfield surface areas. Proper depth perception is provided when the controller's line-of-sight is perpendicular or oblique to the line established by aircraft and ground vehicle movement, and where the line-of-sight intersects the airfield surface at a vertical angle of 35 minutes or more. Required eye level elevation is determined using the following formula:

$E_e = E_{as} + D \tan(35 \text{ min} + G_s)$

Where:

E_e = Eye-level elevation (1.5 m (5') above control cab floor).

E_{as} = Average elevation for section of airfield traffic surface in question.

D = Distance from proposed tower site to section of airfield traffic surface in question.

G_s = Angular slope of airfield traffic surface measured from horizontal and in direction of proposed tower site (negative value if slope is downward towards the tower, positive value if slope is upward towards the tower).

A18.2.7. Siting should conform to airfield and airspace criteria in Chapter 3. Deviations should only be considered when they are absolutely necessary. Any deviations require a waiver.

A18.2.8. Siting should provide an acceptable orientation of the tower cab. The preferred tower cab orientation in relation to the runway is obtained when the long axis of the equipment console is parallel to the primary runway. The reason for this orientation is to allow controllers to face the runway and the ATCT instrument panel without frequently turning their heads to observe events on the runway. Preferred direction should be north (or alternatively, east, south, or west, in that order of preference) when sited in the Northern Hemisphere. Also, locations that place the runway approach in line with the rising or setting sun should be avoided.

A18.2.9. Siting should be such that visibility is not impaired by external lights such as floodlights on the ramp, rotating beacons, reflective surfaces, and similar sources.

A18.2.10. Siting should consider local weather phenomena to keep visibility restriction due to fog or ground haze to a minimum.

A18.2.11. Siting should be in an area relatively free of jet exhaust fumes and other visibility impairments such as industrial smoke, dust, and fire training areas.

A18.2.12. The tower should be sited in an area where exterior noise sources are minimized. For noise level determination, site selection project engineers should enlist the assistance of a host base civil engineer and a bioenvironmental engineer. They should also make use of the Air Force *Bioenvironmental Noise Data Handbook* (AMRL-TR-7550) and noise level data available in the Base Comprehensive Plan. Special efforts should be made to separate the ATCT from aircraft engine test cells, engine run-up area, aircraft parking areas, and other sources of noise.

A18.2.13. Efforts should be made to site the ATCT so that access can be gained without crossing areas of aircraft operations.

A18.2.14. Siting should be coordinated as much as possible with the Base Comprehensive Plan. Particular attention should be given to future construction (including additions or extensions) of buildings, runways, taxiways, and aprons to preclude obstructing controller visibility at a future date.

A18.2.15. The ATCT should be sited so it is free of interference from or interference with existing communications-electronics meteorology or non- communications-electronics meteorology facilities. If an acceptable location is not otherwise obtainable, consider relocating these facilities.

Figure A18.1. Runway Profile and New Control Tower.

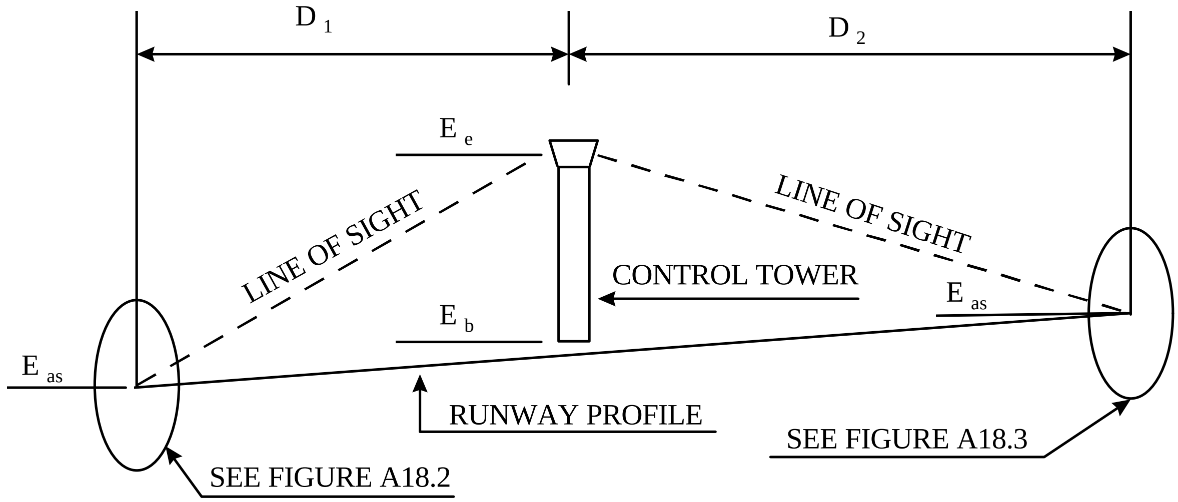
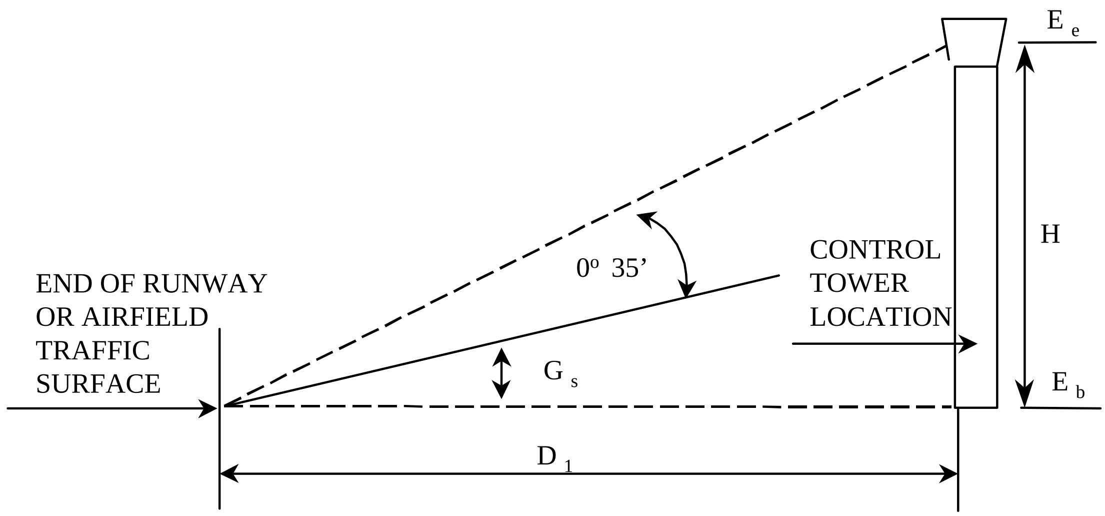


Figure A18.2. Minimum Eye-Level Determination.



Given: E_{as} = 30.5 m (100') MSL E_b = 32.3 m (106') MSL

D_1 = 1,828.8 m (6,000')

G_s = +2 min

Find E_e:

E_e = 30.5 m (100') + H

= 30.5 m (100') + (1,828.8 m (6,000') x tan (35 min + 2 min))

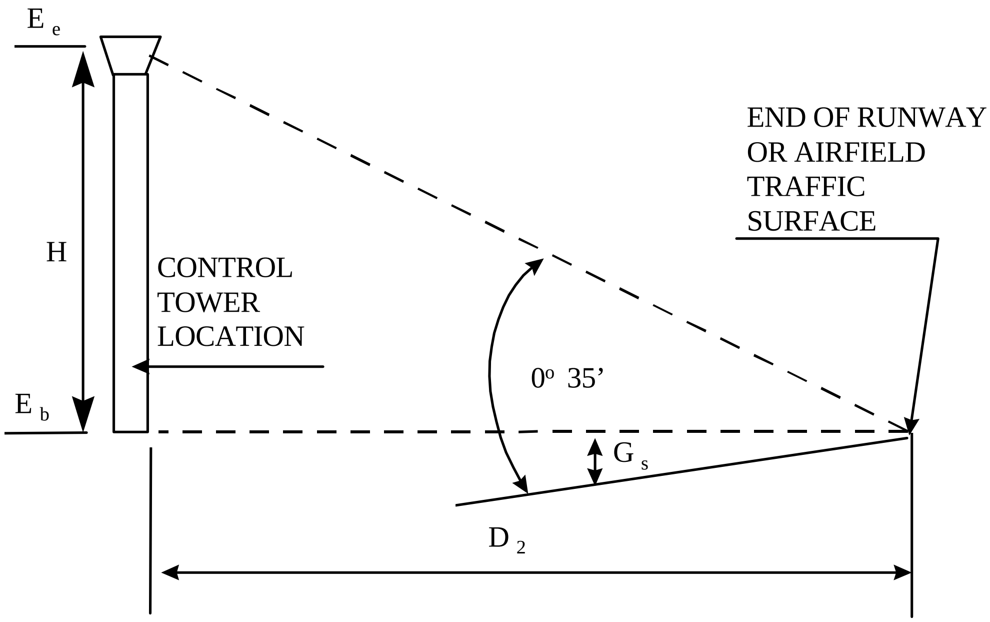
= 30.5 m (100') + (1,828.8 m (6,000') x 0.01076)

= 30.5 m (100') + 19.7 m (64.6')

= 50.2 m (164.6') MSL

Required Eye Level Height = E_e - E_b = 50.2 m (164.6') - 32.3 m (106.0') = 17.9 m (58.6')

Figure A18.3. Minimum Eye Level Measurement.



Given: E_{as} = 33.5 m (110') MSL E_b = 32.3 m (106.0') MSL
D_2 = 1,828.8 m (6,000')
G_s = - 2 min

Find E_e:

E_e = 33.5 m (110') + H
= 33.5 m (110') + (1,828.8 m (6,000') x tan (35 min - 2 min))
= 33.5 m (110') + (1,828.8 m (6,000') x 0.0096)
= 33.5 m (110') + 17.6 m (57.6')
= 51.1 m (167.6') MSL

Required Eye Level Height = $E_e - E_b$ = 51.1 m (167.6') - 32.3 m (106.0') = 18.8m (61.6')

CONCLUSIONS:

a. 18.8 m (61.6') height is larger and therefore controls.

b. Eye height to cab ceiling is 2.1 m (7'), therefore overall height is (2.1 m (7') +18.8 m (61.6') = 20.9 m (68.6')).

c. In this case minimum tower height of 20.4 m (67') will not satisfy requirements (see figure A18.4). Therefore, in order to meet the minimum 35-minute depth perception requirement, an additional floor must be added to increase the overall height of the proposed control tower.

A18.3. Minimum Required Floor Levels. The ATCT height is established by the required number of floor levels or by the 35-minute depth perception requirement, whichever is greater. As a rule, all towers have the following floors, starting with the ground floor (see figure A2-4):

A18.3.1. Chief Controller Office, 3 m (10').

A18.3.2. Training or crew briefing room, 3 m (10').

A18.3.3. Lower electronics equipment room, 3 m (10').

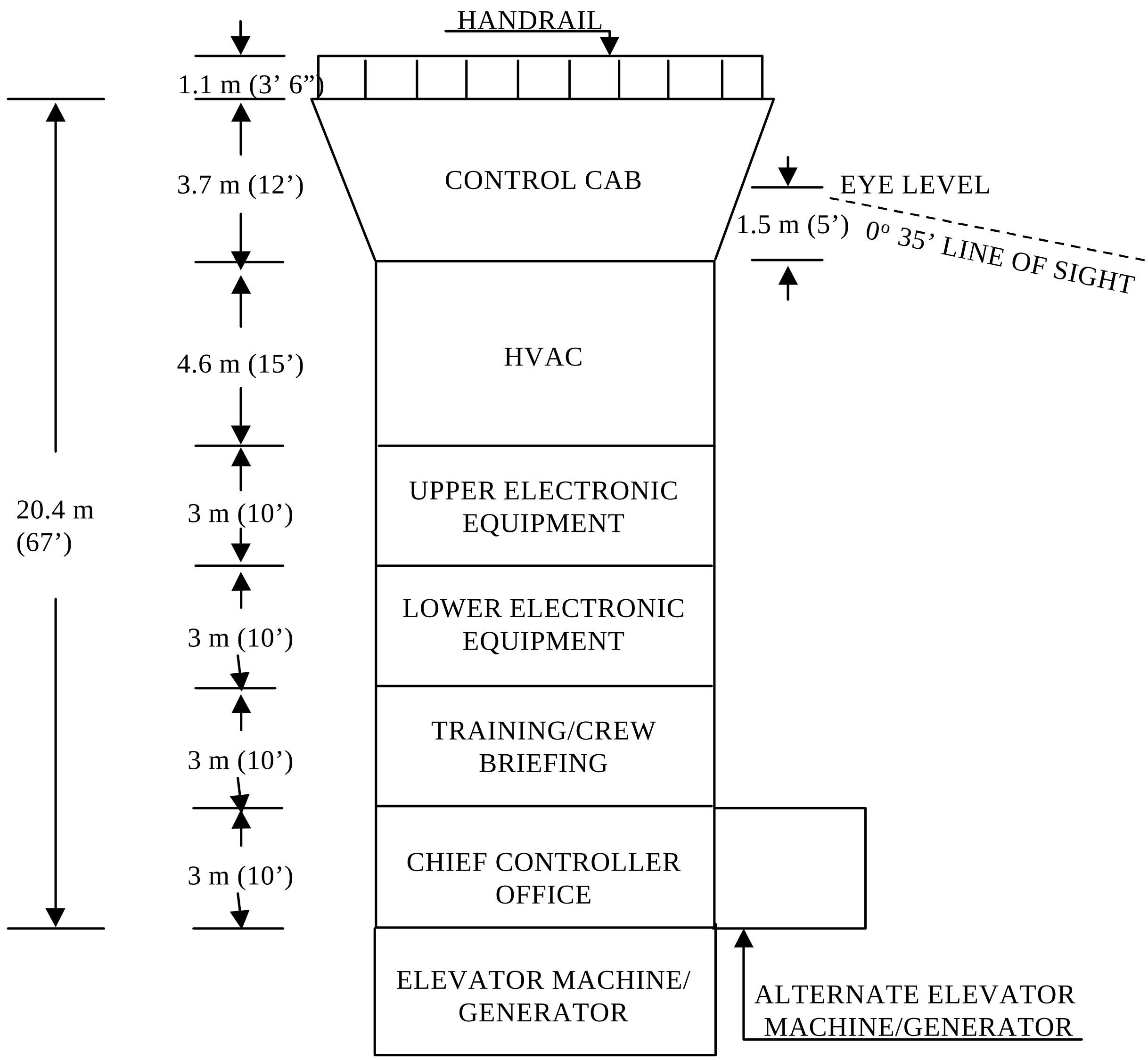
A18.3.4. Upper electronics equipment room, 3 m (10').

A18.3.5. Heating, ventilating, air conditioning room, 4.6 m (15').

A18.3.6. Tower cab, 3.7 m (12') to roofline.

NOTE: If more height is required to obtain the 35-minute depth perception requirement, add additional open intermediate floors with 3 m (10') story height.

Figure A18.4. Minimum Tower Floors.



A18.4. Siting Procedures. A representative from Air Force Flight Standards Agency, Engineering and Systems Integration Branch (AFFSA/XRE), usually serves as project siting engineer for tower siting and a representative from the Engineering Installation Wing (EIW/EICG) usually serves as project engineer for support equipment installation. The project siting engineer, in determining the site recommendation, should fix the ATCT siting and height to the cab floor with assistance from and concurrence of Base Communications (Plans and Programs), Base Airfield Operations Flight (Control Tower and Airfield Management), and Base Civil Engineering offices. The project engineer for support equipment installation will establish internal ancillary equipment requirements based on an assessment of operational needs. Suggested procedures for selecting an ATCT site are in A18.4.1 and A18.4.2 below:

A18.4.1. Office Study by Siting Engineers.

A18.4.1.1. Using elements of the most up-to-date Base Comprehensive Plan, make tentative site selections. Using elements of the Base Comprehensive Plan and the 35-minute depth perception requirements, determine the approximate tower height for each tentative site selected.

A18.4.1.2. Analyze more than one tentative site if appropriate.

A18.4.2. Field Study by Siting Engineers:

A18.4.2.1. Conduct field review of the office-selected tentative sites plus other sites that merit consideration based on discussions with base organizations and the on-location surveys. Consider both siting requirements and siting considerations previously discussed.

A18.4.2.2. Consider in the survey of each site the availability and cost of access roads, utility extensions, and communications cable relocations. The Base Civil Engineer should make the cost estimates. Also, the Base Civil Engineer should evaluate each site to determine the adequacy of ground conditions for structural support of the tower, drainage characteristics, and availability of utilities.

A18.4.2.3. Use profile drawings and shadow maps to determine areas of visibility restrictions due to other structures.

A18.4.2.4. If available and practical, obtain panoramic pictures taken at the proposed tower cab eye level at each tentative site. Photographs should be in color to allow precise interpretation of the surfaces and objects viewed, and should be oriented to true north and for the complete 360-degree horizontal plane around the site. Suggested methods of taking pictures are from a helicopter, cherry picker, or crane boom.

A18.4.2.5. Consider the environmental impact of each site. The Environmental Impact Analysis Process (EIAP) is accomplished through the base civil engineer.

A18.5. Site Recommendations. On completing the field study, siting participants should evaluate each alternative location and should recommend a site. The project siting engineer should then compile all siting data, comparisons, and determinations (including the siting recommendation) in a Statement of Intent (SOI). If practical, the SOI should be signed by all participating personnel, the base communications officer, the Base Civil Engineer, and the base commander. If practical, the SOI must be completed and signed by appropriate personnel before completing the field study. The SOI should include the following:

A18.5.1. Siting recommendation—location, orientation, and height.

A18.5.2. Data comparisons and determinations made during field study.

A18.5.3. Reasons for deviations, if any, from siting requirements.

A18.5.4. Panoramic pictures, if available.

A18.5.5. Economic evaluations, if applicable.

A18.5.6. Major construction requirements to support communications-electronic (C-E) equipment, if applicable.

A18.5.7. Other special considerations.

A18.6. SOI Distribution. The SOI should be distributed to all signatories for programming the support construction and the CE installation. Copies should be retained by the appropriate Base Civil Engineer, Communications, and Airfield Operations Flight offices. Copies should be sent to the MAJCOM and AFFSA/XR. After agreement to a siting recommendation, the host base submits the siting plan to the appropriate MAJCOM for approval. A sample of SOI is shown on the following pages.

A18.7. Sample Statement Of Intent (SOI)

A18.7.1. This is a Statement of Intent (SOI) between HQ AFFSA/XR and (enter appropriate Wing) as it pertains to the (enter date) Site Survey for the proposed new air traffic control tower at (enter appropriate base).

A18.7.2. The purpose of this SOI is to reserve the area required for this project, to note the major allied support requirements needed for later installation of the project equipment, and to serve as a source document for Project Book preparation.

A18.7.3. This survey considers (enter appropriate number) possible control tower locations:

A18.7.3.1. Site No. 1: (Verbally describe location).

A18.7.3.2. Site No. 2: (Verbally describe location).

A18.7.3.3. Site No. 3: (Verbally describe location).

A18.7.4. Site Numbers. (insert appropriate numbers) were rejected for the following reasons:

A18.7.4.1. Site No. _________: (Insert reasons for rejection).

A18.7.4.2. Site No. _________: (Insert reasons for rejection).

A18.7.5. Based on the results of this survey, it is recommended that Site Number ______ be selected for the new control tower. The following rationale supports this recommendation: (Insert rationale.)

A18.7.6. The control tower will be designed using the _____________________________ AFB control tower as a guide. The height of the control tower will be (insert height in meters (feet)). See attached sketch. This height is necessary to provide adequate visibility for taxiways/ runways and to provide the minimum angle of 35 minutes for depth perception to the farthest aircraft traffic surface on the airdrome.

A18.7.7. Allied Support Requirements:

A18.7.7.1. Utilities. Electrical power shall be 120/208, (Insert appropriate number) Hz, plus or minus 10 percent, three-phase, four wire.

A18.7.7.2. Environmental Requirements: Environmental control is required in the control cab and the two electronic equipment rooms in order to sustain effective and continuous electronic equipment operation. The operational limits and the amount of heat dissipated by the equipment are as follows:

Room Heat Dissipated Temp/Humidity

Tower Cab ______BTU _______/_______

Upper Equipment Room ______BTU _______/_______

Lower Equipment Room ______BTU _______/_______

A18.7.7.3. Field Lighting Panel: A field lighting panel, connected to the night lighting vault, will be required for this new structure.

A18.7.7.4. Communications: All existing communication lines/circuitry for NAVAID monitors and radio transmitters/receivers now terminated in the existing control tower shall be provided to the new control tower.

A18.7.7.5. Underground Duct: The existing base duct system must be extended to the proposed control tower site for the field lighting cables, primary power cables, control cables, telephone cables, and meteorological cables.

A18.7.8. After the control tower project has become a firm MCP item, programming action should be initiated by the base Communications Squadron to relocate the electronic equipment from the old control tower.

A18.7.9. Points of contact concerning the survey are __________________, HQ AFFSA/XRE, DSN 858-3986 , and __________________________, 38 EIG/EICG, DSN 884-2888.